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CONTENTS

	PAGE
1. Geologic Maps, Areal and Regional Geology (including Guidebooks)	1
2. Geomorphology	13
3. Structural Geology	18
4. Stratigraphy and Historical Geology	22
5. Paleontology	29
6. Geophysics	33
7. Geochemistry	47
8. Mineralogy and Crystallography	51
9. Igneous and Metamorphic Petrology	52
10. Sedimentary Petrology	56
11. Geohydrology	58
12. Mineral Deposits (including Geochemical Prospecting)	61
13. Fuels	67
14. Engineering Geology	68
15. Miscellaneous	69

SERIALS

The following list gives in full the abbreviated citations used after the titles of papers in this issue of GeoScience Abstracts.

- Akademiya Nauk SSSR, *Izvestiya*, Geologic Series, in English translation (American Geological Institute). Washington, D.C.
- Akademiya Nauk SSSR, *Izvestiya*, Geophysics Series, in English translation (American Geophysical Union). New York.
- Alberta Society of Petroleum Geologists, *Journal*. Calgary.
- American Geophysical Union, *Transactions*. Washington, D.C.
- Association of American Geographers, *Annals*. Lawrence, Kansas.
- Canada, Geological Survey, *Bulletin; Map; Memoir; Paper*. Ottawa.
- Canadian Journal of Botany (National Research Council of Canada). Ottawa.
- Canadian Journal of Physics (National Research Council of Canada). Ottawa.
- Edmonton Geological Society, *Quarterly*. Edmonton, Alberta.
- International Geology Review (American Geological Institute). Washington, D.C.
- Journal of Petroleum Technology (Society of Petroleum Engineers). Dallas, Texas.
- Manitoba, Dept. of Mines and Natural Resources, Mines Branch, *Publication*, Winnipeg.
- Michigan, Geological Survey Division, *Progress Report; Water Supply Report*. Lansing.
- New York State Museum and Science Service, *Bulletin*. Albany.
- Ohio, Division of Water, *Ohio Water Plan Inventory, Report*. Columbus.
- Oil and Gas Journal, Tulsa, Oklahoma.
- Pennsylvania Geological Survey, *Information Circular*. Harrisburg.
- San Diego Society of Natural History, *Memoirs*. San Diego, California.
- Saskatchewan, Dept. of Mineral Resources, *Report*. Regina.
- Saskatchewan Research Council, *Geology Division, Report*. [Regina?].
- Science. Washington, D.C.
- Sociedad Geológica Mexicana, *Boletín*. México, D.F.
- U.S. Bureau of Reclamation, Design and Construction Division, *Technical Memorandum*. Denver, Colorado.
- U.S. Geological Survey, *Bulletin; Geologic Quadrangle Map; Mineral Investigations Map; Miscellaneous Investigations Map; Professional Paper; Reports, Open-File Series*. Washington, D.C.
- U.S. Snow, Ice and Permafrost Research Establishment, *Research Report; Technical Report*. Wilmette, Illinois.
- Virginia Minerals (Virginia, Dept. of Conservation and Development, Division of Geology). Charlottesville.

PURCHASE OF PUBLICATIONS

Those wishing to purchase items abstracted herein should address their orders to the agency, society, or organization indicated in the bibliographic citations preceding the abstracts, or to their local book dealer. The city and state for the serials cited are given above. The American Geological Institute, publisher of GeoScience Abstracts, regrets that it cannot fill purchase orders for abstracted publications other than its own.

1. GEOLOGIC MAPS, AREAL AND REGIONAL GEOLOGY

PART 1. GEOLOGIC MAPS

See also: Areal and Regional Geology 2-3154, 2-3189; Geophysics 2-3361 through 2-3364.

2-3141. Hughes, Owen L. SURFICIAL GEOLOGY, KIRKLAND LAKE, TIMISKAMING AND COCHRANE DISTRICTS, ONTARIO: Canada, Geol. Survey, Map 1 - 1960, descriptive notes, scale 1:126,720, 1960, 2 refs.

Preliminary series map of 1,700 sq. mi. in northern Ontario. Area straddles the Hudson Bay-St. Lawrence divide and includes part of the Great Clay belt (N. of the divide) and Little Clay belt (S. of the divide). Surficial deposits form a discontinuous mantle over the bedrock and comprise glacial and glaciofluvial deposits overlain by Barlow-Ojibway varved clay. Younger fluvial deposits occur in areas along all the major streams, and organic deposits are found in poorly drained situations. The whole area was overridden by a continental ice sheet; concurrent with its northern retreat the area was submerged beneath glacial lake Barlow-Ojibway. --P. Harker.

2-3142. Poole, W.H., and others. GEOLOGY, WOLF LAKE, YUKON TERRITORY: Canada, Geol. Survey, Map 10-1960, scale 1:253,440, 1960.

Preliminary series geological map of about 4,300 sq. mi. just E. of Teslin and bordering the Yukon/British Columbia boundary. All Paleozoic systems are probably represented, but extensive metamorphism limits accurate system dating, although there are some Middle Silurian grapholitic [sic] shales. Younger rocks comprise the Cassiar intrusions, igneous rocks of Jurassic, Cretaceous and Tertiary age, with some later, Tertiary and/or Pleistocene, olivine basalts. The area lies at the northern end of the Cassiar Mountains. Dominant structures are 2 major, NW-trending synclines separated by an anticlinal area occupied by the Cassiar batholith. Ag-bearing galena, wolframite, cassiterite, and sphalerite have been found; fluorite and B minerals occur along the edges of the batholith. --P. Harker.

2-3143. Kachadoorian, Reuben. ENGINEERING AND SURFICIAL GEOLOGY OF THE NENANA-REX AREA, ALASKA: U.S. Geol. Survey, Misc. Inv. Map I-307, scale 1:63,360, contour interval 50 ft., lat. 64°12'30"-64°35'N., long. 148°40'-149°20'W., 1960.

The map shows the engineering geology along a segment of a proposed highway route from Fairbanks to McKinley Park; a brief text and a summary table are included. The text describes the bedrock units, which consist largely of sedimentary and metamorphic rocks, and the abundant surficial deposits, including stream alluvium, alluvial-fan deposits, sand dunes, and glacial deposits. The summary table gives the engineering geology characteristics of these units. --U.S. Geol. Survey.

2-3144. Kachadoorian, Reuben. ENGINEERING GEOLOGY OF THE KATALLA AREA, ALASKA: U.S. Geol. Survey, Misc. Inv. Map I-308, scale 1:63,360, contour interval 100 ft., 1960.

This map, showing the engineering geology along a segment of the proposed highway route between the

Copper River Highway and Icy Bay, includes a brief text and a summary table. The numerous unconsolidated deposits are described in detail, including glacial moraines and outwash, terrace, beach-fan, meadow, swamp, and landslide deposits. The bedrock is briefly discussed. The summary table gives the engineering geology characteristics of the mapped units. --U.S. Geol. Survey.

2-3145. Peterson, Donald W. GEOLOGY OF THE HAUNTED CANYON QUADRANGLE, ARIZONA: U.S. Geol. Survey, Geol. Quad. Map GQ-128, scale 1:24,000, contour interval 40 ft., lat. 33°22'30"-33°30'N., long. 111°0'-111°07'30"W., 1960.

The geologic map shows distribution of early Precambrian igneous and metamorphic rocks, late Precambrian and Paleozoic sedimentary rocks, Mesozoic(?) diabase, and Tertiary volcanic and sedimentary rocks. Complex block faulting and diabase intrusions are shown on the map and on cross sections. The text briefly describes the rock units, structure, geologic history, and mineral deposits. --U.S. Geol. Survey.

2-3146. U.S. Geological Survey. LASSEN VOLCANIC NATIONAL PARK, CALIFORNIA: scale 1:48,000, contour interval 50 ft., 1926, reprinted 1960.

2-3147. Hartshorn, Joseph H. GEOLOGY OF THE BRIDGEWATER QUADRANGLE, MASSACHUSETTS: U.S. Geol. Survey, Geol. Quad. Map GQ-127, scale 1:24,000, contour interval 10 ft., lat. 41°52'30"-42°N., long. 70°52'30"-71°W., 1960.

The early Paleozoic granodiorite and the Carboniferous Rhode Island formation underlie surficial deposits chiefly of glacial origin and alluvial and swamp deposits of postglacial origin. Prominent glacial features include an E.-W. line of southward-facing glacial deltas and associated lake bottom deposits of sand, silt, varved and unvarved clay. Ice-contact stratified drift deposits cover most of the southern third of the quadrangle and include numerous bodies of flowtill. --U.S. Geol. Survey.

2-3148. Houser, Frederick N., and Forrest G. Poole. PRELIMINARY GEOLOGIC MAP OF THE CLIMAX STOCK AND VICINITY, NYE COUNTY, NEVADA: U.S. Geol. Survey, Misc. Inv. Map I-328, 2 sheets, scale 1 in. to 400 ft., 1960.

2-3149. Bell, Henry, 3d, and William C. Overstreet. GEOCHEMICAL AND HEAVY-MINERAL RECONNAISSANCE OF THE CONCORD NE QUADRANGLE, CABARRUS COUNTY, NORTH CAROLINA: U.S. Geol. Survey, Mineral Inv. Map MF-234, scale 1:24,000, lat. 35°22'30"-35°30'N., long. 80°30'-80°37'30"W., 1960.

Alluvial material in stream channels contains detrital Au and scheelite, and alluvial clay contains more than the local average abundance of Cu, Pb, Zn, and Mo. Areas in the Concord 7.5-min. planimetric quadrangle are outlined as guides for exploration. --U.S. Geol. Survey. See also map below.

2-3150. Overstreet, William C., and Henry Bell, 3d. GEOCHEMICAL AND HEAVY-MINERAL RE-

CONNAISSANCE OF THE CONCORD SE QUADRANGLE, CABARRUS COUNTY, NORTH CAROLINA: U.S. Geol. Survey, Mineral Inv. Map MF-235, scale 1:24,000, lat. $35^{\circ}15' - 35^{\circ}22'30''$ N., long. $80^{\circ}30' - 80^{\circ}37'30''$ W., 1960.

2-3151. Comité de la Carta Geológica de México, comp. CARTA GEOLOGICA DE LA REPUBLICA MEXICANA: col. map, scale 1:2,000,000, [México, D.F., México], 1960.

PART 2. AREAL AND REGIONAL GEOLOGY

2-3152. Barry, George S. GEOLOGY OF THE OXFORD HOUSE-KNEE LAKE AREA, OXFORD LAKE AND GODS LAKE MINING DIVISIONS: Manitoba, Dept. Mines & Nat. Resources, Mines Branch, Pub. 58-3, 39 p., 5 geol. maps (4 in pocket), 1959, 25 refs.

A belt of volcanic and sedimentary rocks passes through Oxford and Knee lakes. It is over 60 mi. long and 15 mi. wide. The map-area comprises 700 sq. mi. between $54^{\circ}45' - 55^{\circ}$ N. $94^{\circ}30' - 95^{\circ}30'$ W.

The older rocks of the Hayes River group consist of a lower unit of basalts, andesites, and dacites and an upper unit of volcanic breccias, tuffs, and inter-banded sediments. The younger Oxford group consists of conglomerate, graywacke, subgraywacke, arkose, argillite, quartzite, and schists. It overlies unconformably the rocks of the Hayes River group. Diorite, gabbro, amphibolite, and ultrabasic rocks are the oldest intrusions. Granitic rocks are related to at least 2 magmatic intrusions. Diabase dikes are the youngest rocks. The volcanic and sedimentary rocks are tightly folded into several synclines and anticlines forming part of a synclinorium dipping S. The rocks have been extensively faulted.

The area contains many sulfide occurrences, shown as "S" on maps. Several mineral occurrences are described in detail in the text. These include Fe formation, "asbestos" showings, Au-bearing quartz veins, massive sulfides up to 15 ft. in width, and a Li pegmatite.--Auth.

2-3153. Christiansen, E.A. GEOLOGY AND GROUND-WATER RESOURCES OF THE QU'APPELLE AREA, SASKATCHEWAN: Saskatchewan Research Council, Geology Div., Rept. 1, 53 p., 2 maps, 25 figs., 3 tables, 1960.

The Qu'Appelle area, which comprises about 6,500 sq. mi., lies between the Manitoba-Saskatchewan boundary at 50° N. 104° W. in southeastern Saskatchewan. The climate is semiarid. Average precipitation is about 17 in., and the mean temperature is about 35° F. Soils closely resemble the parent material upon which they are developed, which enables the geologist to interpret the surficial sediments directly from the soil map. Most of the soils in the Qu'Appelle area are within the Black Soil zone.

The surficial sediment is mainly till and lacustrine silt and clay. Sands and gravels in the form of outwash plains are scattered throughout the area. The drift ranges in thickness from a few feet in the E.-central portion of the area to about 700 ft. near Fort Qu'Appelle. The paucity of exposures and subsurface data necessitate that the stratigraphic study be preliminary. Present data suggest, however, that there are at least 3 tills in the Qu'Appelle area. Geological evidence indicates that the area contains

a till margin which represents a re-advance of the ice sheet to a position N. of the Qu'Appelle Valley. The drift is underlain by Upper Cretaceous marine shales or Riding Mountain formation equivalent to the Bearpaw, Belly River, and older formations farther W. The bedrock is exposed in the Qu'Appelle Valley and its tributaries E. of Round Lake where meltwaters have cut deeply into the shale. Locally the hard siliceous Odanah member occurs within the Riding Mountain formation.

The exposed tills are calcareous, oxidized, locally unoxidized, and plastic. The texture of the tills ranges from loam to clay loam. The fact that the clay mineral content of both the tills and the Riding Mountain formation is essentially montmorillonite and minor amounts of illite and kaolinite suggests that this formation is the source of most of the clay in the tills. Echo Lake gravel, believed to be Sangamonian, lies within the drift section.

Slightly to highly mineralized water occurs in the following: Qu'Appelle Valley fill where induced infiltration from the Qu'Appelle Valley lakes and river may be possible; meltwater channel deposits; surficial sand and gravel; Odanah member of the Riding Mountain formation; intertill sand and gravel; and sand and gravel lenses in till. Large quantities of gravel occur in interlobate areas, terraces, outwash plains, and eskers. Interlobate areas are defined by v-shaped re-entrants in the washboard moraines. Large deposits of gravel were formed in close proximity to the glacier which was the source and which provided the necessary gradients for the transportation of the coarse sediments.--Auth.

2-3154. Karlstrom, Thor N.V. SURFICIAL DEPOSITS OF ALASKA (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B333-B335, map, 1960)

A preliminary map (scale 1:1,584,000) released in 1959 for exhibition and open-file inspection, is undergoing final compilation. The map provides, for the first time, a regional synthesis of geologic information on Quaternary glaciation, associated depositional processes, tectonics, and volcanism in Alaska.--Auth.

2-3155. Koschmann, A.H., and M.H. Bergendahl. STRATIGRAPHY AND STRUCTURE OF THE PRE-CAMBRIAN METAMORPHIC ROCKS IN THE TEN-MILE RANGE, COLORADO (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B249-B252, 2 maps, sec., 1960) 2 refs.

In the Tenmile Range of Colorado, Precambrian rocks of sedimentary origin that have undergone high-grade metamorphism form a stratigraphic sequence more than 22,000 ft. thick that comprises the following 4 mappable units: granulite (oldest), banded gneiss, migmatite, and pink quartz-biotite-plagioclase gneiss (youngest). The major fold in the area is a syncline trending eastward or southeastward, flanked by anticlines. The folded rocks are cut by faults of Precambrian to Tertiary age.--Auth.

2-3156. Thomas, Leo A. GUIDEBOOK FOR THE TWENTY-FOURTH ANNUAL TRI-STATE GEOLOGICAL FIELD CONFERENCE, NORTH-CENTRAL IOWA, OCTOBER 8 AND 9, 1960, HEADQUARTERS - MARSHALLTOWN: [25] p., illus., maps, secs., tables, 1960.

The guidebook consists of a road log for the conference. The trip provides an opportunity to observe the major portion of the Mississippian through Permian(?) systems of N.-central and E.-central Iowa. Particular emphasis is given to carbonate diagenesis as a major controlling factor in the creation of rock texture, lithologic boundaries, and facies. From the view point of the stratigrapher, the processes of diagenesis must be considered constantly, inasmuch as the processes can mask a proper evaluation of the environment of deposition.--Auth.

2-3157. Association of Missouri Geologists. SEVENTH ANNUAL MEETING, OCTOBER 7 & 8, 1960. MIDDLE MISSISSIPPIAN AND PENNSYLVANIAN STRATIGRAPHY OF ST. LOUIS AND ST. LOUIS COUNTY, MISSOURI. Sponsored by the Department of Geology and Geological Engineering, Institute of Technology, St. Louis University, St. Louis: 13 p., map, 6 secs., 1960.

Road log of a traverse through the City of St. Louis and eastern St. Louis County, an area that shows the transition between the Illinois basin and the Ozark uplift. Columnar sections show the thickness and lithology of the Warsaw formation, the Spergen, St. Louis, and Ste. Genevieve limestones of middle Mississippian age; also the Des Moines and Missouri series of Pennsylvanian age. The unconformity between the 2 geologic periods is demonstrated.--K. G. Brill.

2-3158. Smedes, Harry W. EARLY TERTIARY VOLCANIC GEOLOGY OF AN AREA NORTH AND WEST OF BUTTE, MONTANA (In: U.S. Geological Survey. Geological Survey Research 1960: Its Prof. Paper 400-B, p. B23-B24, sec., 1960) ref.

Over 6,000 ft. of quartz latitic volcanic rocks lie unconformably on the Boulder batholith and older rocks. Their extrusion was followed by repeated block faulting, one of whose results was to form a graben about 1,200 ft. deep W. of Butte. Sheets of welded tuff collapsed chaotically into this graben and probably buried segments of truncated metalliferous quartz veins.--Auth.

2-3159. Campau, D. E., and H. W. Anisgard, eds. BILLINGS GEOLOGICAL SOCIETY, 11TH ANNUAL FIELD CONFERENCE, SEPTEMBER 7-10, 1960. WEST YELLOWSTONE-EARTHQUAKE AREA: 316 p., illus., maps (6 in pocket), charts (1 in pocket), secs., diags., tables, [Billings, Montana], 1960, refs.

This guidebook is dedicated to the recording of the geologic and human aspects of the Hebgen Lake-Madison Valley earthquake of Aug. 17, 1959. The papers are listed under the following headings: historical papers, earthquake papers, tectonic and structural geology, surface geology, geomorphic papers, stratigraphic papers, paleobotany, economic geology, and geologic road logs. Papers and road logs for which no abstracts have been received and for which there are no adequate summaries or conclusions are listed below in the order in which they appear in the guidebook. The others are separately abstracted immediately following this abstract.

Bragg, Addison R. Vigilante Country, p. 15-19.
Howell, J. V. Geology Plus Adventure: The Story of the Hayden Survey, p. 20-23.
Nile, Stephen W. The Hebgen Lake Earthquakes, p. 24-30.

Hadley, Jarvis B. The Madison Landslide, p. 45-48.

Marler, George D. The 1959 Hebgen Lake Earthquake Alters Yellowstone's Hot Springs, p. 61-66.

Kirk, C. H. The Earthquake Damage to Hebgen Dam and the Necessary Repair Program, p. 67-70.

Ball, R. M. The Madison Earthquake and its Effects, p. 71-77.

Bayles, R. G. A Doctor's Report, p. 78-80.

Burley, Robert M. Earthquake, p. 81-82.

Reynolds, George W. Mixing Verbs and Fault Planes, p. 83-85.

Andretta, D. B., and S. A. Alsup. Geology and Cenozoic History of the Norris-Elk Creek Area, Southwest Montana, p. 185-190.

Cressman, Earle R., and Roger W. Swanson. Permian Rocks in the Madison, Gravelly, and Centennial Ranges, Montana, p. 226-232.

Kummel, Bernhard. The Triassic of Southwestern Montana, p. 233-238.

ROAD LOGS

First Day

McMannis, W. J., and D. L. Keil. Geologic Road Log, Hebgen Lake Earthquake Area via U.S. Highway 191, p. 275-279.

Second Day

McMannis, W. J., and D. L. Keil. Geologic Road Log, West Yellowstone to Madison Canyon Slide via Reynolds Pass via U.S. Highway 191 and State Highway 287, p. 280-283.

McMannis, W. J., and Fred Honkala. Geologic Road Log, Madison Canyon Slide to Southern Gravelly Range via Centennial Valley, p. 284-288.

Hall, W. B., and W. J. McMannis. Alternate Geologic Road Log, West Yellowstone to Bozeman, via U.S. Highway 191, p. 289-300.

Third Day

McMannis, W. J., and J. B. Hadley. Geologic Road Log, Southern Gravelly Range to Jack Creek via Ennis via Forest Service Roads, p. 301-308.

McMannis, W. J. Alternate Geologic Road Log, Junction of Highway 287 and Reynolds Pass to Ennis via State Highway 287, p. 309-311.

McMannis, W. J. Exit Geologic Road Log, Ennis to Bozeman via State Highways 287 and 289, p. 312-313.

2-3160. Witkind, Irving J. THE HEBGEN LAKE, MONTANA, EARTHQUAKE OF AUGUST 17, 1959 (In: Campau, D. E., and H. W. Anisgard, eds. Billings Geological Society, 11th Annual Field Conference...: p. 31-44, 19 illus., map, 4 diags., table, [Billings, Montana], 1960) 5 refs.

Since late Tertiary time (Miocene?), the geologic pattern of the Hebgen Lake area has involved the repeated dropping and tilting of fault blocks. At 11:37 p. m. on Aug. 17, 1959, the pattern was repeated. Two fault blocks E. of the Madison Range, and one W. of the range, dropped and tilted, synchronously reactivating the marginal normal faults. Geodetic data are not available to indicate how the core of the range was deformed. Release of the accumulated strains resulted in a major earthquake that was felt over 600,000 sq. mi.

Prominent fault scarps appeared coincident with or closely parallel to the reactivated faults. The major scarps, N. of Hebgen Lake, face valleyward (southward), have maximum displacement of about 20 ft. near their midpoints, and offset surficial debris, chiefly colluvium.

The subsidence and northward tilting of the fault block containing Hebgen Lake displaced the lake

northward and caused the surface of the lake to oscillate in great waves. The seiche thus created lasted for 11 1/2 hours, and initially was able to crest Hebgen Dam 4 times. When the lake quieted, the N. shore was submerged, and the S. shore was emerged.

Damage to Hebgen Dam, an earthfill structure with a concrete core, was extensive. The concrete core was cracked and twisted out of line, the earthfill slumped unevenly, and several concrete piers in the spillway were cracked or knocked askew.

During or shortly after the earthquake, parts of former Highway 287 slid into Hebgen Lake. In places along the N. shore, a mixture of sand and water was extruded from fissures to form sand spouts. About a week after the main shock, an earthflow in Kirkwood Canyon began to move, felling trees and draining a small lake.--Auth.

2-3161. Woodard, F.W. RED CANYON FAULT, HEBGEN LAKE, MONTANA, EARTHQUAKE, AUGUST 17, 1959 (In: Campau, D.E., and H.W. Anisgard, eds. Billings Geological Society, 11th Annual Field Conference...: p. 49-55, 5 illus., [Billings, Montana], 1960) 3 refs.

The Red Canyon fault is a normal fault on the W. side of a zone of high angle reverse faults bordering the eastern flank of a large N.-tilted block. This fault zone, along with other tilted blocks in the area, had its start during the Laramide revolution and late stage of Cenozoic mountain building.

The fault is 14 mi. long, and by including a short paralleling normal fault near the NW. end, it forms a fault zone 15 mi. long. For the purpose of this paper the zone is divided into 3 sections: 1) Grayling Creek section, the southern SE.-trending section, 2) Red Canyon section, the central crescent-shaped section, and 3) North Fork section, the northwestern termination including other short paralleling normal faults.

These sections differ not only in their magnitude, but by the amount and direction of dip of the beds they cut, the direction of movement, and the way in which they are expressed at the surface. This does not imply 3 different times of movement. The entire fault probably moved at about the same time.

Some of the interesting phenomena occurring along the fault zone are described. The discussion starts at the S. end of the Grayling Creek section, proceeds northward to the Hebgen Lake valley, and then moves to the mountainous Red Canyon and North Fork sections.--From auth. introd.

2-3162. McAleer, Joseph F. A ROTATIONAL FAULT BLOCK IN THE MADISON RIVER EARTHQUAKE AREA (In: Campau, D.E., and H.W. Anisgard, eds. Billings Geological Society, 11th Annual Field Conference...: p. 56-60, illus., map, diag., [Billings, Montana], 1960)

In addition to the major geological phenomena that resulted from the Montana earthquake of 1959, a minor fault scarp, Quake Lake scarp, is significant because of its evident uniqueness. The trace of the fault is horseshoe shaped and may be divided into an upper and lower limb. The upper limb has a maximum vertical offset of 14 ft. with the S. or valley side downthrown, dips 85° to 90° S., exposes bedrock, and is the result of normal faulting. The major portion of the lower limb is made up of colluvial material not in place, dips 55° to 65° S., has a maximum vertical displacement of 12 ft., with the N. or uphill side thrust over the downhill side.

The block of ground, 760 ft. long and 530 ft. wide, between the major portions of the 2 limbs was sub-

jected to a rotational or tilting movement on an axis that passes through a point on the closed end of the horseshoe shaped fault. This point coincides with the spot where the normal faulting ends and the over-riding or thrust faulting begins. In addition to the rotational movement, a slight counter-clockwise twisting or hinge movement also developed.--Auth.

2-3163. Eardley, A.J. PHASES OF OROGENY IN THE DEFORMED BELT OF SOUTHWESTERN MONTANA AND ADJACENT AREAS OF IDAHO AND WYOMING (In: Campau, D.E., and H.W. Anisgard, eds. Billings Geological Society, 11th Annual Field Conference...: p. 86-91, 5 maps, [Billings, Montana], 1960) 7 refs.

Five maps show the evolution of uplifts and basins during Late Cretaceous and Cenozoic time in southwestern Montana and adjacent areas. The maps contain the names of formations and isopachs of their thicknesses, uplifts, thrust faults, volcanic fields, and Basin and Range faults.--Auth.

2-3164. Hamilton, Warren B. LATE CENOZOIC TECTONICS AND VOLCANISM OF THE YELLOWSTONE REGION, WYOMING, MONTANA, AND IDAHO (In: Campau, D.E., and H.W. Anisgard, eds. Billings Geological Society, 11th Annual Field Conference...: p. 92-105, 3 illus., 4 maps, [Billings, Montana], 1960) 14 refs.

During early Tertiary time, varied volcanic rocks were deposited upon the eroded Laramide uplifts of the Yellowstone region. During the middle Tertiary, these uplifts and the volcanic rocks, were segmented obliquely by block faults, and the present mountain ranges were inaugurated. The fault blocks plunge on dip under the Snake River basin and the Yellowstone plateau; the plateau represents the high lava-filled end of the basin.

During the Pliocene, an ancestral Yellowstone plateau, at about the same elevation as the present one, was formed by welded tuffs of alkaline rhyolite, accompanied by flows of the same composition. A caldera 30 mi. in diameter probably formed by the collapse of this rhyolite sheet into the underlying magma chamber.

During the late Quaternary, vast flows of viscous rhyolite filled this caldera and overflowed to the W. across a buried connection between the Madison and Teton ranges onto the Snake River plain. Some of these flows have been dated relative to glaciations. These flows brought the level of the Yellowstone plateau back up to its previous position. Now, the Pliocene rhyolites form an outer ring, nearly 10 mi. wide, bounding the Quaternary flows on all sides save the SW. The magma chamber beneath the caldera was in the center of the pre-Pliocene structural and topographic basin. Rhyolites of Pliocene and Quaternary ages are alkaline rocks, compositionally similar to silicic differentiates of basaltic magmas. Field and petrologic relations suggest that the Yellowstone plateau may be the silicic crust of an extrusive basaltic lopolith.

The Snake River basin, adjacent to the Yellowstone plateau, is formed on basalt flows with subordinate flows and tuffs of rhyolite. Island Park basin is a caldera, 18 mi. in diameter, rimmed by rhyolite and filled with basalt.

The Snake River basin (and its E. end, the Yellowstone plateau) cuts across most Mesozoic and Cenozoic structures. Around its upper part are encountered many of the highest mountains of the northern

Rocky Mountains. So many structures, Laramide as well as late Cenozoic, are systematically related to the upper end of the basin that the factors which produced it must operate well beyond its borders.--Auth.

2-3165. Honkala, Fred S. STRUCTURE OF THE CENTENNIAL MOUNTAINS AND VICINITY, BEAVERHEAD COUNTY, MONTANA (In: Campau, D. E., and H. W. Anisgard, eds. Billings Geological Society, 11th Annual Field Conference...: p. 107-113, illus., map, diag., [Billings, Montana], 1960) 16 refs.

This paper is a survey of the structure of the Centennial Mountains which are located in Beaverhead County in southwestern Montana and adjacent Clark County in Idaho. Precambrian metamorphics, Paleozoic to Cenozoic sediments and Cenozoic volcanics are present in the mountains. The mountains have an E.-W. trend and are bordered on the N. by the Centennial fault, which in places is marked by a 3,000-ft. scarp. Recent movement has taken place along the scarp. The mountains are cut by several lesser N.-S.-trending faults, and some folding is present in Mesozoic rocks which underlie volcanics in the western part of the mountains.

The tectonic history of the region includes a lower Cretaceous pre-Laramide uplift, an upper Cretaceous Laramide uplift, and Paleocene and upper Paleocene or lower Eocene Laramide orogenic uplifts. Post-Laramide uplifts are recorded in Miocene and Oligocene time, with erosion dominating much of Pliocene time and uplift in late Pliocene and/or Pleistocene time. Volcanic activity occurred at several times during the Tertiary period.--Auth.

2-3166. Mann, John A. GEOLOGY OF PART OF THE GRAVELLY RANGE AREA, MONTANA (In: Campau, D. E., and H. W. Anisgard, eds. Billings Geological Society, 11th Annual Field Conference...: p. 114-127, 5 maps, 4 secs., [Billings, Montana], 1960) 23 refs.

The Gravelly Range area is located in the southern part of Madison County, Montana. Over 8,000 ft. of sedimentary rocks are exposed in this area. All of the periods of the Paleozoic and Mesozoic, with the exception of the Ordovician and Silurian, are represented as well as part of the Cenozoic era. Angular unconformities were observed between the Precambrian Cherry Creek series and the Cambrian Flathead sandstone, between the Jurassic Morrison formation and the Cretaceous Kootenai formation, and between the undifferentiated Cretaceous and the Paleocene(?) limestone-cobble conglomerates. Evidence of an erosional disconformity was observed between the Mississippian Madison group and the overlying Mississippian-Pennsylvanian Amsden formation.

The present structural features of the area studied were largely developed during the period of orogenic compression which occurred during the late Mesozoic and early Cenozoic. The patterns of these features were governed by early Proterozoic basement structural lineations, geosynclinal depression and accumulation of sediments, and the development of intermittently active block segments in the foreland area. The structural features which resulted from the orogeny reflect the influence of the established lines of weakness or strength, the consequent "bypass" or "yield" potential of the delineated segments, and the differing thickness and competence

of the sedimentary sections involved.

Following this orogenic episode, the area was uplifted and eroded, developing topography that appeared very much like that of the present. The Oligocene period of volcanic activity buried this topography, and a new cycle of erosion began on the surface thus formed. Late Tertiary planation was succeeded by uplift and erosion which stripped away most of the volcanic cover and superimposed the existing drainage upon the underlying structure. The topography was somewhat modified by Alpine glaciation during the Pleistocene, and erosion has continued to the present.--Auth.

2-3167. Beck, Frederick M. GEOLOGY OF THE SPHINX MOUNTAIN AREA, MADISON AND GALLATIN COUNTIES, MONTANA (In: Campau, D. E., and H. W. Anisgard, eds. Billings Geological Society, 11th Annual Field Conference...: p. 129-134, 5 illus., sec., table, [Billings, Montana], 1960) 17 refs.

The Sphinx Mountain area is located in the W.-central part of the Madison Range. Approximately 13,000 ft. of sedimentary rocks crop out, and range in age from Cambrian to Tertiary. Two little-studied formations - the Livingston and the Sphinx - crop out only in the Sphinx Mountain area in the Madison Range.

The Upper Cretaceous Livingston formation is 2,100 ft. thick, a thickness greater than had previously been reported. The Tertiary Sphinx conglomerate rests with angular discordance on the Livingston formation. The Sphinx exhibits large-scale cross-stratification, small folds, and numerous bedding-plane faults.

Two pulses of Laramide compression from the SW., one pre- and one post-Sphinx, have folded and faulted the rocks. Precambrian rocks have been thrust onto overturned Paleozoic and Mesozoic rocks in the western part. Numerous strike-slip faults accompanied the thrusting.--Auth.

2-3168. Tompson, Willard D. GEOLOGY OF THE NORTHERN PART OF CHERRY CREEK METAMORPHIC ROCKS, MADISON CO., MONTANA (In: Campau, D. E., and H. W. Anisgard, eds. Billings Geological Society, 11th Annual Field Conference...: p. 135-147, 15 illus., 4 maps, 4 diags., [Billings, Montana], 1960) 17 refs.

Kyanite and sillimanite occur in the Precambrian schist, gneisses, and pegmatites of the Cherry Creek metamorphic rocks S. of Ennis, Montana. The metamorphic rocks formed as a result of the regional metamorphism of a thick sequence of sedimentary rocks, mostly limestones and shales. The metamorphic rocks are about 3,050 ft. thick and consist of interlaminated dolomite-marble, dolomitic marble, kyanite- and sillimanite-bearing schists and gneisses, amphibolites, and gneisses and schists, undivided. The rocks are tightly folded, and a large isoclinal syncline, which plunges steeply to the E(?), repeats the section in the map area.

Three types of pegmatites occur in the map area, and each displays a preference for certain host rocks: kyanite pegmatites occur in kyanite schist or gneiss; microcline-quartz-muscovite-tourmaline pegmatites occur in marble and in kyanite schist; and microcline-quartz pegmatites are most prominent in quartz-feldspar gneiss.

The greatest concentration of kyanite pegmatites occurs along the crest of folds in the kyanite schist. The kyanite pegmatites apparently formed by pro-

cesses of metamorphic differentiation, in which Al ions were reconstituted in and/or added to a quartz segregation and subsequently grew on kyanite nuclei already present in the quartz.

Kyanite is the stable phase in the kyanite schist and is metastable in the kyanite pegmatites, as indicated by the inversion kyanite-sillimanite. The inversion is probably due to increased temperature and reduced pressure. Petrographic evidence indicates that the PT changes may have been produced by shearing of the pegmatite during its formation.--Auth.

2-3169. Hadley, Jarvis B. GEOLOGY OF THE NORTHERN PART OF THE GRAVELLY RANGE, MADISON COUNTY, MONTANA (In: Campau, D.E., and H.W. Anisgard, eds. Billings Geological Society, 11th Annual Field Conference... p. 149-153, 2 maps, table, [Billings, Montana], 1960) 7 refs.

In the Gravelly Range, W. of the Madison Valley in southwestern Montana, Paleozoic rocks about 5,000 ft. thick range in age from Middle Cambrian to Permian; Mesozoic rocks about 4,500 ft. thick range from Lower Triassic to Upper Cretaceous. The lithology and thickness of each of 21 mapped Paleozoic and Mesozoic stratigraphic units and the extent of several locally distributed Tertiary and Quaternary units are summarized as background information for a field excursion in the area. A structure map, scale approx. 1:200,000, is included.

Variations from the usual Paleozoic sequence in southwestern Montana show that 800 ft. of Middle and Upper Cambrian and Ordovician rocks were eroded from a local uplift in pre-Upper Devonian time, and that 650 ft. of Upper Mississippian rocks (Big Snowy group or its equivalents), present in the western part of the area, are absent in the eastern part probably because of uplift and erosion before deposition of the Amsden formation.

The structure of the western part of the area is dominated by Laramide folds and thrust faults, including low-angle faults on which Precambrian and Paleozoic rocks have been carried several miles eastward over Upper Cretaceous rocks. The eastern part of the area is dominated by high-angle faults associated with downfaulting of the adjacent Madison Valley in late Tertiary and Quaternary time. Tertiary rocks, mainly cobble gravel and various volcanic rocks probably of Oligocene age, were deposited on a surface now tilted northeastward from the crest of the Gravelly Range to near the present level of the Madison River. Farther S., the Madison Valley seems to have subsided mainly by faulting on both sides.--Auth.

2-3170. McThenia, Andrew Wolfe, Jr. GEOLOGY OF THE MADISON RIVER CANYON AREA NORTH OF ENNIS, MONTANA (In: Campau, D.E., and H.W. Anisgard, eds. Billings Geological Society, 11th Annual Field Conference... p. 155-164, 2 maps, 7 diags., 3 tables, [Billings, Montana], 1960) 6 refs.

Compositional layering, lineation measurements, and mapping of rock units indicate steeply plunging anticlinal folds in the area of the Madison River canyon, N. of Ennis, Montana. The folding maintains an approximately constant NNE. trend but changes in direction of plunge rather abruptly near the center of the area. The southern portion of the area consists of a broad open anticline plunging 70°N, 20°E. However, in the northwestern portion the folds plunge steeply to the SW. Two theories are advanced

to explain the origin of the observed structures: 1) Initial cylindroidal folding about a horizontal axis trending N. 20°E. was followed by a second period of folding with the deforming stresses nearly at right angles to those of the first period; 2) A single stress field with negative tetragonal symmetry (2 axes of extension and one of compression) with the positive axis trending essentially NW.-SE. could produce such a fold pattern as was observed. The noncylindroidal nature of the folding may be attributed to the original attitude of the compositional layering.

A representative section of the Pony gneiss, 6,147 ft. thick, consists of interlayered plagioclase-quartz gneisses, microcline-plagioclase quartz gneisses, and amphibolites. In addition a thick unit of sericitic quartzite was observed. All the mineral assemblages observed are stable throughout the almandine-amphibolite facies. The Pony series is believed to have been derived from the metamorphism of interstratified limey shales, sandy limestone, and sandstones.--Auth.

2-3171. de la Montagne, John. GEOMORPHIC PROBLEMS IN THE MADISON VALLEY, MADISON COUNTY, MONTANA: AN INTRODUCTION AND SYNTHESIS (In: Campau, D.E., and H.W. Anisgard, eds. Billings Geological Society, 11th Annual Field Conference... p. 165-169, 4 illus., map (in pocket) [Billings, Montana], 1960) 9 refs.

The project, carried out by 6 students of the Earth Science Dept., Montana State College, was designed to discover and describe the effects of late Cenozoic tectonic activity upon the landscape and to integrate to this end 4 separate phases of work: 1) surface features of the Madison Valley floor, 2) alluvial fans along the Madison Range front, 3) recent faults and adjacent related geomorphic features, and 4) the history of the Norris Hills area and its effect in controlling the characteristics of the Cenozoic Madison drainage and deposition.

After a study of the literature and general reconnaissance of the entire area by the group, individual problems were chosen and began. Field research and inspection was followed by oral presentations and group critique, with the final work presented as a symposium of 4 articles and results compiled on a geomorphic map. Although all the facts ascertained are not profound, many are important contributions, and the project was a success educationally.--From auth. introd. The 4 papers follow this abstract.

2-3172. Paul, H.P., and L.A. Lyons. QUATERNARY SURFACES ALONG THE MADISON VALLEY FLOOR FROM ENNIS LAKE TO ENGLISH GEORGE CREEK, MONTANA (In: Campau, D.E., and H.W. Anisgard, eds. Billings Geological Society, 11th Annual Field Conference... p. 170-173, 3 illus., 3 profiles, [Billings, Montana], 1960) 3 refs.

The origin of the surfaces in the Madison Valley are closely related to factors controlling the regimen and base level of the ancestral Madison River drainage. A working chronology interrelating various stages of upfilling and downcutting follows:

The first working supposition is the interpretation that an older sequence of Cenozoic rocks accumulated in the valley. The youngest lithified rock in this sequence is Pleistocene in age. The varied lithologies in this earlier sedimentary sequence indicate that many types of depositional conditions existed, ranging from those of torrential streams to quiet water, including warm spring precipitation. Possible cause

or such accumulations are suggested.

Following accumulation of the above rocks, topography of considerable relief may have developed as indicated by the sporadic occurrence of the sequence at various locations in the valley.

The second stage of valley filling, possibly following an erosional episode, involved the accumulation of Pleistocene to Recent glacial outwash and alluvial material which buried the earlier Cenozoic lithified sequence. Thickness of gravel varies from less than 10 ft. to more than 200 ft., and the conditions of deposition varied considerably, but in most cases streams were the main agent. Deposits generally range from rounded to subrounded pebbles and cobbles; size grading is common. Crossbedding and imbrication of pebbles away from the center of the valley indicates that the depositing streams flowed toward the center of the valley. Sources were in both the Gravelly and Madison ranges, as well as from the S.

After the filling of the valley with glacial outwash, the river started degrading. The Cameron surface was formed during a time of extended stability.

A graded condition was probably reached by the river during the development of the Cameron surface. The Cameron surface commonly truncates the underlying material. However, in some places, a layer of loess truncates the underlying gravel.

Several shorter periods of rejuvenation caused the river to cut the intermediate surfaces, which are generally less than 1/4 mi. wide. Normal meander sweep was also involved in the establishment of several subsidiary and unmatched levels undifferentiated on the geologic map.

The Madison River is presently forming a flood plain which is more than 2 mi. wide N. of Ennis but decreases in width southward. This flood plain is slightly dissected. Evidence indicates that the present flood plain of the river near Ennis Lake is at or the lowest level to which the river has cut in the recent past.--From auth. concl.

-3173. Sloane, Bruce C. ALLUVIAL FANS FROM JACK CREEK TO MILL CREEK ALONG THE WEST FLANK OF THE MADISON RANGE, MONTANA (In: Campau, D. E., and H. W. Anisgard, eds. Billings Geological Society, 11th Annual Field Conference...: p. 174-177, illus., 2 profiles, [Billings, Montana], 1960) 2 refs.

Alluvial fans of varying sizes occur along the W. flank of the Madison Range, SE. of Ennis, Montana. The fans lie on the downthrown side of a recently active fault zone, with the apices of the fans at or near the fault line. It is probable that the fans have been formed by the streams in response to faulting to maintain pre-fault gradients. A profile along Cedar Creek shows that the creek maintains an even gradient on both sides of the fault, with the stream itself descending the fan in an incised channel, indicating that the stream is not at this time actively building the fan, but is degrading it. Major fan development probably took place during late Pleistocene time, and only slight fault movement has occurred since then.--Auth.

-3174. Shelden, Arthur W. CENOZOIC FAULTS AND RELATED GEOMORPHIC FEATURES IN THE MADISON VALLEY, MONTANA (In: Campau, D. E., and H. W. Anisgard, eds. Billings Geological Society, 11th Annual Field Conference...: p. 178-184, illus., 3 secs., profile, [Billings, Montana], 1960) refs.

Recent fault scarps are useful in interpreting a part of the tectonic history of the Madison Valley, since they tend to follow older and established fault zones. Comparison of geomorphic features along the western flank of the Madison Range indicates 3 geomorphic areas that are outlined by 3 Recent fault scarps. The area N. of Bear Creek comprises the northern tectonic block and is characterized by a landslide, slumping, faceted spur ends, deep V-shaped valleys, abrupt rise in topography from the valley floor, and large alluvial fans that are younger than the Cameron surface. With the exception of Jordan Creek, no evidence remains of valley glaciers that may have extended onto the valley floor. The area between Indian Creek and Bear Creek forms the central tectonic block and is characterized by a deeply-dissected pediment and partially exhumed fossil topography. Indian Creek exhibits a deep V-shaped canyon, which is in sharp contrast to the South Fork of Indian Creek. The area S. of Indian Creek comprises the southern tectonic block and is characterized by the absence of slumping and faceted spur ends, but does exhibit abundant evidence of valley glaciers which reached the Madison Valley floor. Alluvial fans S. of Bear Creek are older than the Cameron surface.

The geomorphic features which characterize the northern tectonic block suggest at least 1,000 ft. of movement along the fault zone since middle or late Pleistocene time. This conclusion is supported by the peculiar drainage pattern of Bear Creek, which, rather than taking the shortest route to the Madison River, turns northward after leaving the mountains and parallels the river for some 10 mi. before joining it. This drainage pattern may result from eastward tilting of the Cameron surface. Gravels exposed in road cuts near Jack Creek dip approximately 3° to 6°E. and are truncated by the westward sloping Cameron surface. Imbrication in the gravels demonstrates westward flow of streams.

The central tectonic block is uplifted relative to the northern tectonic block as suggested by the deeply dissected pediment and exhumed topography S. of Bear Creek. It is interesting that the Recent fault scarp at Indian Creek is on line with a fault zone displayed on topographic maps that coincides with the Aug. 17-formed fault scarps extending along the NE. shore of Hebgen Lake.

Indian Creek makes an arcuate turn to the S. away from the uplifted central tectonic block. This peculiar drainage may be the result of late Cenozoic uplift of the central tectonic block or a southward tilt of the Indian Creek-Wall Canyon block. The linear drainage of Moose Creek after it leaves the mountain range suggests that it is fault-controlled. It is possible that the high, prominent bench that can be seen from most parts of the valley is an uplifted block caught in the Wall Canyon fault zone.

The Madison Valley is one of the younger major valleys in the southwestern Montana area. Northward dipping late Cenozoic beds along the North Meadow Creek fault zone, tilted glacial outwash near Moose Creek, Recent fault scarps, and comparison of geomorphic features along the western flank of the Madison Range testify that the valley is still tectonically active.--Auth. concl.

2-3175. Hall, William B. MULTIPLE GLACIATION IN THE MADISON AND GALLATIN RANGES, SOUTHWESTERN MONTANA (In: Campau, D. E., and H. W. Anisgard, eds. Billings Geological Society, 11th Annual Field Conference...: p. 191-199, 7 illus., [Billings, Montana], 1960) 9 refs.

This part of Montana shows a considerable body of evidence indicating very recent minor ice accumulation in the highest peaks, fairly recent development of valley glaciers of limited size, and older development of a more extensive valley glacier system.

Prior to all of these ice advances there must have been a much more extensive development of ice cover, one which must have antedated some of the modern valley cutting. Presumably the ice during this period of greatest expansion must have overwhelmed most of the terrain below 9,500 ft. near the high peaks, and below 8,000 ft. in the vicinity of the Gallatin Valley in order to leave the deposits where we now find them.

If this assumption is correct, the earliest ice advance cannot be thought of as typical of Alpine glaciation, but rather as a small glacier-field or ice-cap somewhat comparable to a piedmont ice sheet. Consequently, we should not expect landforms typically developed by ordinary Alpine glaciers, but the less spectacular forms such as polished bedrock, glacial grooves, roches moutonnees and drumlins.

Continuing study of the new high-altitude air photos, new topographic maps, and new stereo air-oblques, in color, coupled with field-checking of critical areas, indicate giant grooves and swarms of drumlin-like mounds in parts of northern Yellowstone Park formerly believed unglaciated.

With additional detailed work we may be able to grasp the possibility of the former existence of an area of extensive ice cover over much of the higher parts of the Upper Gallatin region, Beartooth Plateau, and Yellowstone Plateau.--From auth. concl.

2-3176. Hall, William B. MASS-GRAVITY MOVEMENTS IN THE MADISON AND GALLATIN RANGES, SOUTHWESTERN MONTANA (In: Campau, D. E., and H. W. Anisgard, eds. Billings Geological Society, 11th Annual Field Conference...: p. 200-206, 7 illus., [Billings, Montana], 1960) 4 refs.

Mass-gravity movements are so numerous and involve such a large area in the Madison and Gallatin ranges that they must be considered an important process in the geologic development of the whole region. Indeed, much of the topographic detail is directly due to the effects of various gravity movements.

If the Madison and Gallatin ranges are representative of a significant part of southwestern Montana and adjacent mountain areas, we may conclude that a vast region is open to productive investigation of a great wealth of mass-gravity phenomena, which may heretofore have escaped special notice. Future studies in this already challenging region should contribute greatly to our understanding of mass wastage as a major process in the evolution of mountain scenery.--Auth. concl.

2-3177. Hanson, Alvin M. CAMBRIAN OF THE MADISON RIVER VALLEY AREA (In: Campau, D. E., and H. W. Anisgard, eds. Billings Geological Society, 11th Annual Field Conference...: p. 207-212, 2 secs., [Billings, Montana], 1960) 18 refs.

Cambrian strata of the Madison River valley area comprise 6 formations with a total thickness of up to 1,500 ft. The lower 3 formations of Middle Cambrian age represent a transgressive sequence beginning at the base with a coarse-grained, poorly sorted quartzitic sandstone (Flathead sandstone, 0-200 ft.). The Flathead grades upward into a green-gray sandy shale unit (Wolsey shale, 100-200 ft.) which in turn grades upward into a typically mottled, micrograined

limestone which is dolomitized to the W. (Meagher limestone, 400-1,000 ft.). Overlying the Meagher limestone is a green-gray shale unit (Park shale, 100-200 ft. of Middle Cambrian age), lithologically similar to the Wolsey, which intergrades with the underlying Meagher as well as with an overlying carbonate unit. The latter (Pilgrim limestone, 0-400 ft.) of Upper Cambrian (Dresbachian) age is characterized by skeletal limestone, limestone pebble conglomerate, and massive mottled oölitic limestone (dolomitized to the W.). The uppermost Cambrian unit (Red Lion, of Franconian age) consists of micaceous sandstone, shale and pebble limestone (or dolomite). Post-Cambrian - pre-Devonian erosion has removed the Red Lion as well as the Pilgrim and Park from part of the Madison Valley area.--Auth.

2-3178. Hintze, Lehi F. ORDOVICIAN STRATIGRAPHY IN WESTERN MONTANA AND ADJACENT STATES (In: Campau, D. E., and H. W. Anisgard, eds. Billings Geological Society, 11th Annual Field Conference...: p. 213-216, map, [Billings, Montana], 1960) 10 refs.

Ordovician strata are found to the W., S., and E. of the field-conference area but are lacking in the conference area and northward. It seems likely that the Bighorn dolomite once covered the area, perhaps to a thickness of a few hundred feet, but that it was removed by pre-Devonian erosion. The field-conference area was part of the craton during Ordovician time. Thick Lower and Middle Ordovician deposits accumulated to the W. and S. of the area in the Cordilleran geosyncline, which later became non-geosynclinal in behavior during the deposition of the vast carbonate sheet of Bighorn age in W.-central North America.--Auth. summ.

2-3179. Strickland, John W. SUMMARY OF MISSISSIPPIAN STRATIGRAPHY, WESTERN WYOMING AND VICINITY (In: Campau, D. E., and H. W. Anisgard, eds. Billings Geological Society, 11th Annual Field Conference...: p. 217-225, 2 maps (1 in pocket), chart (in pocket), [Billings, Montana], 1960) 65 refs.

The area discussed in this report includes approximately 142,000 sq. mi. covering the western half of Wyoming and parts of Montana, Idaho, and Utah. The primary aim of the writer is to clarify the interrelationship of the Mississippian strata throughout this area. In addition, data are presented which support the following contentions:

1) The Sappington formation, of lower Kinderhookian age is present in western Wyoming and eastern Idaho.

2) Upper Madison strata (post-Mission Canyon) of Meramecian age, equivalent to the upper Brazer of Utah and the Charles of Montana, are present throughout most of Wyoming. 3) The Madison of Wyoming should have group status. Lodgepole, Mission Canyon, and Charles time-rock equivalents are widespread and recognizable. Locally, because of environmental changes during time of deposition, the Mission Canyon-Lodgepole strata are difficult to differentiate. 4) The upper part of the Madison is Meramecian in age and appears to be separated from the underlying Early Mississippian strata by a regional disconformity.

5) Use of the term "Brazer" should be discouraged in western Wyoming and southwestern Montana unless adequately defined, because, in the type locality in the Crawford Mountains of Utah, it is equivalent

to beds of both the Charles (upper Madison) and Mission Canyon of Wyoming and Montana, and is composed of a facies of limited geographic extent.

6) Rocks of Chesterian age are present in western Wyoming and eastern Idaho. The strata of Chesterian age, formerly considered to be the upper part of the Brazer formation in northern Utah, should be separated from it and raised to group status with appropriate formation subdivisions.

7) The use of the term Sacajawea should be discouraged because it is applicable only to the upper member of the upper Madison of Meramecian age in the Wind River Basin.--From auth. introd.

2-3180. Moritz, Carl A. SUMMARY OF THE JURASSIC STRATIGRAPHY OF SOUTHWESTERN MONTANA (In: Campau, D. E., and H. W. Anisgard, eds. Billings Geological Society, 11th Annual Field Conference...: p. 239-243, 2 maps, chart, sec., [Billings, Montana], 1960) 14 refs.

Rocks of Jurassic age were recognized in southwestern Montana by early investigations, but they were not studied in detail until the late 1940's when the U.S. Geological Survey and several oil companies began measuring and sampling stratigraphic sections throughout the area.

The Jurassic rocks of the northern Rocky Mountains were first referred to as the Ellis formation, but this stratigraphic unit has subsequently been raised to group rank and subdivided into the following formations:

Ellis group	{	Swift formation Rierdon formation Sawtooth formation
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The lowermost unit of the Ellis group in southwestern Montana consists of argillaceous limestones and calcareous shales that range in thickness from 0 to about 150 ft. The maximum known thickness is found on the E. side of the Middle Fork of Little Sheep Creek in sec. 29, T.15 S., R.8 W., Beaverhead County, Montana. The lithologic characteristics of the Sawtooth formation are very similar to those of the Twin Creek limestone of western Wyoming and eastern Idaho. The outcrops of the Sawtooth formation and Twin Creek limestones are almost invariably covered with a veneer of splintery fragments of argillaceous limestone and calcareous shale. The basal portion is usually made up of 60 to 70 ft. of gray and gray-green calcareous shales that weather into splintery, pencil-shaped fragments. The upper unit is composed of yellow-brown, argillaceous limestones that weather into blocky fragments.

The most abundant fossils are *Gryphaea* and *Camptonectes*, which are usually found in the more calcareous and less argillaceous beds. The Sawtooth formation unconformably overlies the Thaynes formation (lower Triassic) and is apparently conformably overlain by the Rierdon formation.

The best developed sections of the Rierdon formation are found on the N. side of Little Water Creek (sec. 10, T.13 S., R.10 W., Beaverhead County, Montana) in the Tendo Mountains and on the E. side of Little Sheep Creek (sec. 29, T.15 S., R.8 W., Beaverhead County, Montana), S. of Garfield Mountain. The unit consists chiefly of limestones and interbedded shales. One of the characteristic features of this formation is the presence of oölitic limestones. The uppermost unit of the Rierdon formation in the Little Water Creek section consists of gray-green, argillaceous limestones interbedded with minor amounts of calcareous

shale. The maximum known thickness in southwestern Montana is slightly more than 100 ft.

The Swift formation is the thinnest and most widespread formation of the Ellis group in southwestern Montana. It consists chiefly of glauconitic sandstones and shales. The glauconitic sandstones are usually gray green, medium to coarse grained and contain some chert fragments. The upper portion consists of dark greenish-brown calcareous sandstone that grades upward into sandy shale. The formation is nonresistant and is usually not well exposed. The maximum thickness that has been measured by the writer in this region is about 35 ft.

The marine Jurassic rocks of southwestern Montana are overlain by the nonmarine Morrison formation. It is made up of greenish-brown, reddish-brown, grayish-green, and yellowish shales and mudstones; gray sandy shales, and occasional gray, thin, fresh-water sandstones. In the Little Sheep Creek section in sec. 29, T.15 S., R.8 W., Beaverhead County, Montana, the base of the Morrison formation is marked by a 2-ft. bed of gray, freshwater limestone.

The thickness of the Morrison formation in this region is usually less than 400 ft. It is about 400 ft. thick along the Idaho-Montana border in the Beaverhead Mountains and thins to less than 100 ft. in central Beaverhead County. On the W. side of Fossil Creek in sec. 4, T.12 S., R.2 W., Madison County, Montana, in the Gravely Range the formation is 268 ft. thick. This is one of the best exposed sections of the Morrison know to the writer.--Auth.

2-3181. Becker, Herman F. THE TERTIARY FLORA OF THE RUBY-GRAVELLY BASIN IN SOUTHWESTERN MONTANA (In: Campau, D. E., and H. W. Anisgard, eds. Billings Geological Society, 11th Annual Field Conference...: p. 244-252, 8 illus., map, sec., [Billings, Montana], 1960) 13 refs.

Two new Tertiary floras from the upper Ruby River basin in southwestern Montana are discussed. They are a component of the greater Madison Valley-Yellowstone earthquake area and are presented in telescoped description to fit the scope of the guidebook. The Ruby basin contains Tertiary sediments and volcanics with fossiliferous outcrops of late lower Eocene plants (Mormon Creek flora) comprising 57 species of which 16 are new. The adjacent late upper Oligocene Ruby paper shales comprise 85 species of which 28 are new. Both floras are taxonomically not yet exhausted. A third, the York Ranch flora, with an estimated 100 species, and floristically apparently unrelated to the former 2, is at present under study. The floras range from warm-temperate to temperate-xeric and reflect prevailing regional climates for this time span. They are chiefly deciduous with a gymnospermous admixture and contain leaves, flowers, fruits, seeds, bracts, cones, and pollen.--Auth.

2-3182. Dorf, Erling. TERTIARY FOSSIL FORESTS OF YELLOWSTONE NATIONAL PARK, WYOMING (In: Campau, D. E., and H. W. Anisgard, eds. Billings Geological Society, 11th Annual Field Conference...: p. 253-260, 3 illus., map, sec., [Billings, Montana], 1960) 20 refs.

Unusual features of the fossil forests include: 1) they are more extensive in area than any other known fossil forests; 2) most of the petrified trees are still standing upright in position of original growth; 3) they contain, in addition to petrified trees, impressions of leaves, cones, and seeds of over 100 differ-

ent kinds of plants; 4) in one of the sections is a succession of 27 distinct fossil forests, one on top of the other, in a thickness of about 1,700 ft. of volcanics; a new cross-section of this sequence is presented.

Locations of 13 plant-bearing sites are shown on a map of a portion of northeastern Yellowstone Park. The list of fossil species now recognized includes about 10 ferns, 3 horsetail rushes, 10 conifers, 1 questionable cycad, 6 monocots, and over 70 broad-leaved dicots.

Comparisons with living forests indicate lowland, warm-temperate to subtropical conditions with abundant rainfall, comparable to modern forests of southeastern and S.-central United States.

The floras show affinities with the Green River, Aycross, and Valley Ranch floras of the Rocky Mountain region and the lone flora of California. The unusually rapid deposition of the plant-bearing volcanics is believed to have been spasmodic, with no major interruption from late early Eocene time until well into the middle Eocene.--Auth.

2-3183. Tutten, William D. CARROT BASIN ANTICLINE, GALLATIN COUNTY, MONTANA (In: Campau, D.E., and H.W. Anisgard, eds. Billings Geological Society, 11th Annual Field Conference...: p. 261-264, map, sec., [Billings, Montana], 1960)

The Phillips Petroleum No. 1 Carrot basin is of interest for the following reasons: 1) it was drilled on a surface structure located in a basin of deformed sedimentary rocks ranging in age from the Cambrian to the Cenozoic; 2) most of the rocks are of marine origin; and 3) Paleozoic and Mesozoic formations of this area can be correlated with equivalent beds, some of which produce oil, in the Big Horn basin more than 100 mi. to the SE.--From auth. concl.

2-3184. Gorder, John D. THE LIMA ANTICLINE (In: Campau, D.E., and H.W. Anisgard, eds. Billings Geological Society, 11th Annual Field Conference...: p. 265-267, map, sec., [Billings, Montana], 1960).

The Cities Service No. 1 Emerich should be considered a valid test to its total depth of 11,213 ft., with the well probably bottomed at or near the top of the Rierdon formation [Jurassic]. It was estimated that the Tensleep formation [Pennsylvanian] on this major anticline [Beaverhead County, Montana; Clark County, Idaho] could be expected at a depth from 12,500 ft. to 13,000 ft. Sediments encountered on the Lima anticline well were hard, tight, and low in reservoir qualities.--Auth. concl.

2-3185. Hogberg, Rudolph K. GEOLOGY OF THE RUBY CREEK IRON DEPOSIT, MADISON COUNTY, MONTANA (In: Campau, D.E., and H.W. Anisgard, eds. Billings Geological Society, 11th Annual Field Conference...: p. 268-272, map, [Billings, Montana], 1960) 18 refs.

The Ruby Creek iron deposit is in pre-Beltian Precambrian rocks on the E. flank of the Gravelly Mountains approximately 20 mi. S. of Ennis, Montana.

A detailed study indicates the following geological history: 1) deposition of sedimentary strata including iron formation, intrusion of mafic sills, tight folding and regional metamorphism during Precambrian time; 2) peneplanation followed by deposition of thick sequence of Paleozoic and Mesozoic sediments; 3) Laramide uplifting and erosion; 4) deposition of sedimentary strata and extrusion of volcanic material in Tertiary time; and 5) late Cenozoic transverse

faulting and erosion.

The metamorphosed sedimentary rocks of the Ruby Creek area consist of lentils and lenses of iron formation, micaceous quartzite, and dolomitic marble interstratified within biotite-quartz schist. Amphibolite sills, quartz veins, and acidic volcanic rocks also occur within the deposit area.

The iron formations are composed of thinly banded or laminated beds of magnetite or iron silicate alternating with bands of chert. It is suggested that the ferriferous beds were deposited as oxide (magnetite) and silicate (minnesotaite) lithologic facies under intermediate to slightly reducing environmental conditions.--Auth.

2-3186. New York State Geological Association. GUIDEBOOK FOR FIELD TRIPS, 32ND ANNUAL MEETING... HAMILTON COLLEGE, CLINTON, NEW YORK, MAY 13-14, 1960. Prepared by David Hawley and Donald B. Potter: [61] p., maps, secs., table, 1960, refs.

The field trip guidebook contains summary descriptions of the geology, geologic sketch maps, and road logs for 4 field trips in the Utica region. The field trips are: A. To examine the basal Silurian unconformity, the Clinton group, and the Vernon shales in Frankfort Gulph, S. of Frankfort. B. To visit the small oolitic hematite mine of the Clinton Metallic Paint Company, at Clinton. C. To visit localities of several Adirondack Precambrian rock types, the Piseco dome, and smaller structures in the Remsen, Ohio, and Piseco Lake quadrangles. D. To examine faults and unconformities on the S. flank of the Adirondacks, and stratigraphy from upper Cambrian through most of the Trenton group, in the area from Little Falls to Trenton Gorge of West Canada Creek. There is a small-scale geologic map and a summary of the Precambrian geology of the Adirondack mountains.--D. Hawley.

2-3187. Kansas Geological Society. GUIDEBOOK, TWENTY-FIFTH FIELD CONFERENCE... IN CO-OPERATION WITH THE OKLAHOMA GEOLOGICAL SURVEY AND THE UNIVERSITY OF WICHITA. NORTH-EASTERN OKLAHOMA: 125 p., illus., maps, secs., [Wichita?], Sept. 1960, refs.

The Kansas Geological Society undertook this field study to better acquaint its members with the pre-Des Moinesian stratigraphy of the Oklahoma-Kansas region. This conference is particularly desirable because many of the oil and gas reservoirs of Kansas occur in these rocks. This trip affords the Kansas geologist an excellent opportunity to see in the field the relationships of the rocks which are of vital importance to him in the subsurface. Furthermore, this study is of primary importance in relation to the advent of the Arkoma basin as a major oil- and gas-producing province. Long the scene of shallow gas production, the Arkoma basin has recently accounted for a considerable number of good gas discoveries from Atokan sandstones.--From introd.

Contents:

Areal Map of the Arkoma Basin, p. 7.
Geological Map of Field Conference Area, p. 8.
Road Log, First Day, Hulbert, Tahlequah, Marble City, Fort Gibson Area, p. 9-29.
Road Log, Second Day, Wagoner, Spavinaw, Vinita Area, p. 30-43.
Carboniferous Problems of the Mid-Continent Area, by Carl C. Branson, p. 44-47.
Regional Relations of Pre-Desmoinesian Rocks,

GEOLOGIC MAPS, AREAL AND REGIONAL GEOLOGY

- Central Mid-Continent Region, by George G. Huffman, p. 48-71.
- The Atoka Formation in Northeastern Oklahoma, by Jack G. Blythe, p. 72-81.
- Geology of the Oklahoma Ozark Region, by George G. Huffman, p. 82-109.
- Silurian and Devonian Strata in the Marble City Area, Sequoyah County, Oklahoma, by Thomas W. Amsden, p. 110-112.
- Paleozoic Deposition in Northern Arkansas, by John C. Maher, p. 113-117.
- The Lakes of Northeastern Oklahoma, by George G. Huffman, p. 118-122.
- 2-3188. Field Conference of Pennsylvania Geologists, 25th, Lancaster, 1960. **SOME TECTONIC AND STRUCTURAL PROBLEMS OF THE APPALACHIAN PIEDMONT ALONG THE SUSQUEHANNA RIVER.** Edited by Donald U. Wise and Marvin E. Kauffman: 99 p., 23 figs. incl. illus., maps, secs., diags., 1960, refs.
- This field conference, held Oct. 22-23, 1960, was sponsored by the Dept. of Geology at Franklin and Marshall College, Lancaster. Many tectonic and structural problems are of special interest within a particular zone of the Piedmont; others carry over from zone to zone in a broader picture of Appalachian orogeny. This trip is designed to pass through the several zones, stopping at a few key outcrops to highlight some of the problems and to provide an open air forum for their discussion. Twelve stops are planned, each of which illustrates a particular tectonic or structural problem. It is hoped that the trip will further stimulate some thinking and discussion of the tectonic processes within the Piedmont, how these processes vary from zone to zone or are superimposed within a single zone, and how all these processes fit into the total picture of Appalachian orogeny.--From introd.
- Contents:
Wise, Donald U. An Introduction to Some Tectonic and Structural Problems of the Appalachian Piedmont Along the Susquehanna River, p. 1-9.
Road Log - First Day, p. 11-16.
Road Log - Second Day, p. 17-21.
Stratigraphic Summary, p. 22.
Kauffman, Marvin E. Piedmont Stratigraphy Near the Susquehanna River, p. 23-26.
Hopson, C. A. Stop 1. The Port Deposit Granodiorite Complex, p. 27-31.
Hopson, C. A. Stop 2. Conowingo Contact Zone, Port Deposit Granodiorite, p. 32-34.
Lapham, Davis M. Stop 3. Geology of the Cedar Hill Serpentine Quarry, p. 35-38.
Wise, Donald U. Stop 4. The Martic Problem and the New Providence Railroad Cut, p. 39-48.
Kauffman, Marvin E. Stratigraphic Relations of the Glenarm Series, p. 49-52.
Wise, Donald U. Stop 5. The Pequea "Silver" Mine, p. 53-59.
Wise, Donald U. Stop 6. Williamsons Park - Late Stage Shearing and Higher Order "S" Surfaces, p. 60-63.
Wise, Donald U. Stop 7. Oyster Point Quarry, p. 64-67.
Wise, Donald U. Stop 8. Chickies Rock, p. 68-75.
Wise, Donald U. Stop 9. Rheems Quarry, p. 76-83.
McLaughlin, Dean B. Stop 10. Notes on the New Oxford Formation and the Limestone Conglomerate at Conoy Creek, p. 84-88.
- Wise, Donald U. Stop 11. Nappe Structures and the Annville Quarry, p. 89-91.
- Bricker, Owen. Stop 12. Ordovician Volcanics of the Bunker Hills, Lebanon County, Pennsylvania, p. 92-99.
- 2-3189. Overstreet, William C., and Henry Bell, 3d. **GEOLOGIC RELATIONS INFERRED FROM THE PROVISIONAL GEOLOGIC MAP OF THE CRYSTALLINE ROCKS OF SOUTH CAROLINA** (In: U. S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B197-B199, map, 1960) 6 refs.
- A provisional geologic map of the crystalline rocks of South Carolina has been compiled on a scale of 1:250,000 from county soil maps. It shows the extension of the Kings Mountain belt across the state, a young syenite(?) ring complex, and small granitic plutons.--Auth.
- 2-3190. Geological Society of America, Rocky Mountain Section. **GUIDEBOOK FOR FIELD TRIPS, THIRTEENTH ANNUAL MEETING... HELD AT THE SOUTH DAKOTA SCHOOL OF MINES AND TECHNOLOGY, RAPID CITY, SOUTH DAKOTA, APRIL 28, 29, AND 30, 1960.** Prepared by members of the geological staffs, the South Dakota School of Mines and Technology and the Homestake Mining Company: 20 p., 2 maps, sec., [Rapid City], 1960.
- This guidebook consists of 5 road logs: Rapid City to Belle Fourche via Sturgis, Deadwood, and Spearfish; Rapid City to First Stop on U.S. 16 Northwest of Keystone; Rapid City to Badlands National Monument and Scenic; Rapid City to Homestake Mine, Lead; Tertiary Intrusives and Precambrian Rocks near Lead.
- 2-3191. South Texas Geological Society. 1959 **FIELD TRIP, DECEMBER 4-5, 1959. MESOZOIC STRATIGRAPHY AND STRUCTURE, SALTILLO-GALEANA AREAS, COAHUILA AND NUEVO LEÓN, MÉXICO:** [103] p., 18 figs. incl. illus, maps (1 in pocket), secs., 8 pls. (in pocket) incl. maps, secs., San Antonio, Aztec Photocopy Company and Spotlight Oil Reports, 1960, 44 refs.; text in English and Spanish.
- The field trip area embraces parts of 2 major, regional geologic provinces in northeastern Mexico - the Rio Grande embayment and the Sierra Madre Oriental. The Sierra Madre Oriental is a distinct tectonic element characterized by great, doubly-plunging, commonly asymmetrical folds developed mainly in Lower Cretaceous carbonates and Upper Jurassic carbonate and clastic strata. The fold belt extends NNW. from the vicinity of the Isthmus of Tehuantepec to Monterrey, Nuevo Leon, where it arcs westerly almost to Ramos Arispe, a small town N. of Saltillo, Coahuila. E. of Ramos Arispe and Saltillo the anticlinal folds plunge steeply to the W. and disappear beneath the thick Parras shale of Gulfian age; thus, the fold belt recedes southward in this area only to develop again as a continuous system of great folds a few miles S. of Saltillo. From this area the tectonic belt trends WNW. to Torreon, Coahuila, from which city it extends NW. to the United States border.
- The Rio Grande embayment includes parts of the physiographic Gulf Coastal Plain and the physiographic Coahuila Ridge and Basin Province of Humphrey. The latter element, also a distinct tectonic element and here designated tectonically the Coahuila Mar-

ginal Folded Province, is situated on the southwestern flank of the Rio Grande embayment between the Gulf Coastal Plain and the Sierra Madre Oriental.--From p. A-2.

Contents:

- Introduction and Regional Geologic Summary of Field Trip Area, Southeastern Coahuila and Western Nuevo Leon, by Grover E. Murray, p. A1-22.
- Preliminary Report on the Structure of the Parras Basin in the Vicinity of Saltillo, Coahuila, by Alfred E. Weidie, James A. Wolleben and Grover E. Murray, p. B1-18.
- Difunta Strata of Tertiary Age, Coahuila, Mexico, by Grover E. Murray, James A. Wollenben and Donald R. Boyd, p. C1-8.
- Preliminary Report of Intrusive Gypsum, Sierra Del Fraile, State of Nuevo Leon, Mexico, by Grover E. Murray and J.R. Wall, p. D1-12.
- Road Log from U.S. Customs, Laredo, Texas, to Monterrey Airport, Nuevo Leon, Along Pan American Highway, p. E1-8.
- Road Log from Saltillo West on Torreon Highway (Mexico 40), p. F1-13.
- Road Log from Saltillo North on Eagle Pass Highway (Mexico 57), p. G1-7.
- Road Log from Saltillo South and East to Galeana and Iturbide, Nuevo Leon, p. H1-12.

2- 3192. West Texas Geological Society. **GEOLOGY OF THE DELAWARE BASIN AND FIELD TRIP GUIDE-BOOK, SEPT. 29TH, 30TH, AND OCT. 1ST, 1960:** 100 p., 34 illus. (3 in pocket), 22 figs. incl. maps (U.S. Geol. Survey, Oil & Gas Inv. Prelim. Map 90, scale 1 in. to approx. 2 1/3 mi., in pocket), secs. (1 in pocket), correlation chart (in pocket), Midland, 1960, 37 refs.

A guidebook and geological study summarizing Permian stratigraphy, structure and subsurface geology with annotated road logs and a compendium of oil field studies.

Reef deposition, submarine slides, and turbidity current deposition are featured in an illustrated road log. The Toyah, Coyanosa, El Mar, Geraldine-Ford, Grice, and Twofreds oil and gas fields, Texas-New Mexico, are presented in papers by geologists intimately associated with their discovery and development. Two special studies of specific problems in the Delaware basin, (Upper Permian Correlations in Southeast New Mexico and Adjacent Parts of West Texas; Recent Domal Structures of Southeastern New Mexico) are included.

Geologic sections of key wells within the basin, sonic log correlations, and other miscellaneous additions comprise the surface and subsurface study of the Delaware basin as an oil province.--J. Carl.

2- 3193. Wyoming Geological Association. **15TH ANNUAL FIELD CONFERENCE GUIDEBOOK 1960. OVERTHRUST BELT OF SOUTHWESTERN WYOMING AND ADJACENT AREAS.** Edited by Donald P. McGookey, and Daniel N. Miller, Jr.: 285 p., illus. (4 in pocket), maps (2 in pocket), charts, secs. (4 in pocket), diags., [Casper], 1960, refs.

The locale for this conference made possible observations of a portion of Wyoming's largest sedimentary basin, the Green River basin, and the complex structure and stratigraphy involved in the belt forming the western margin of the basin. This guidebook contains papers explaining pertinent features of the oil and gas fields, regional and local

structures, and reviews of the stratigraphy. Technical papers and road logs are listed below:

GENERAL GEOLOGY

Eardley, A.J. Phases of Orogeny in the Fold Belt of Western Wyoming and Southeastern Idaho, p. 37-40.

Elliott, D.H. Reconnaissance Photogeology - Cokeville NE Quadrangle, Wyoming, p. 43.

Ross, A.R., and J.W. St. John. Geology of the Northern Wyoming Range, Wyoming, p. 45-56.

Hinds, G.W., and W.E. Andrau. Geology of a Portion of the Northern Snake River Range, Bonneville County, Idaho, p. 57-60.

Espach, Ralph H., Jr., and Frank Royse, Jr. Stratigraphic Variations in the Eastern Big Hole Mountains, Teton and Bonneville Counties, Idaho, p. 61-71.

Scholten, Robert. Sedimentation and Tectonism in the Thrust Belt of Southwestern Montana and Eastern Idaho, p. 73-83.

Skinner, Robert E. Tectonic Elements of the Northern Green River Area of Wyoming, p. 87-88. **STRATIGRAPHY**

Cohenour, Robert E. Resume of Precambrian Geology in the Vicinity of the Overthrust Belt of Western Wyoming, p. 91-97.

Lochman-Balk, Christina. The Cambrian Section of Western Wyoming, p. 99-108.

Hintze, Lehi F. Ordovician Tectonics of Western Wyoming and Vicinity, p. 111-115.

Sando, William J., and J. Thomas Dutro, Jr. Stratigraphy and Coral Zonation of the Madison Group and Brazer Dolomite in Northeastern Utah, Western Wyoming, and Southwestern Montana, p. 117-126.

Verville, George J., and James A. Momper. Pennsylvanian Fusulinids and Preliminary Series Correlation in Southwestern Wyoming, p. 127-128.

Skinner, Robert E. Proposed Kendall Sandstone Member of the Gypsum Spring Formation, p. 129-130.

Hale, Lyle A. Annotations to Accompany Cretaceous Correlation Chart, p. 131-135.

Hale, Lyle A. Frontier Formation - Coalville, Utah and Nearby Areas of Wyoming and Colorado, p. 137-146.

Heppe, W. Charles. A Brief Summary of the Stratigraphy of the Almond and Lewis Formations of the Washakie Basin, Sweetwater County, Wyoming, p. 147-151.

Hallock, Allan R. Stratigraphy and Correlation of the Mesaverde Group and Ft. Union Formation, Southern Bridger Basin, Wyoming, p. 153-154.

McGrew, Paul O., and Henry W. Roehler. Correlation of Tertiary Units in Southwestern Wyoming, p. 157-158.

Milton, Charles, and Joseph J. Fahey. Green River Mineralogy - A Historical Account, p. 159-162.

Koenig, Karl J. Bridger Formation in the Bridger Basin, Wyoming, p. 163-168.

Randall, Arthur G. Catalog of Formation Names for Overthrust Belt and Vicinity, Western Wyoming, p. 169-177. **STRUCTURE**

Goering, M.W., and B.G. Smith. Preliminary Geologic Interpretation, Amerada Petroleum Corporation No. 1 Chicken Creek Unit, SW SW Section 30, T. 22N., R. 117W., Lincoln County, Wyoming, p. 179-180.

Murray, Floyd E. An Interpretation of the Hilliard Thrust Fault, Lincoln and Sublette Counties, Wyoming, p. 181-186.

Long, George I. W. Afton Anticline, Lincoln County, Wyoming, p. 187-188.
ECONOMIC GEOLOGY

Veatch, A. C. Early Oil Exploration in Uinta County, p. 189-193.

Krueger, Max L. Occurrence of Natural Gas in the Western Part of Green River Basin, p. 195-209.

Michael, Robert H. Hogsback and Tip Top Units, Sublette and Lincoln Counties, Wyoming, p. 211-216.

Woodward, Thomas C. Willow Creek Gas Field, p. 217-220.

Bayley, Richard W. Precambrian Taconite Deposits near Atlantic City, Fremont County, Wyoming, p. 223-225.

Gordon, Ellis D., and others. Occurrence and Quality of Water in the Northern Bridger Basin and the Adjacent Overthrust Belt, Wyoming, p. 227-247.

Hand, H. D. Resume of Trona Activity in the Green River Basin, Wyoming, p. 249-250.

Townsend, Don H. Economic Report on the Kemmerer Coal Field, p. 251-255.

ROAD LOGS

First Day's Trip, August 3, 1960. Area South to Elkol and Cumberland Gap and North to La Barge and Big Piney Oil and Gas Fields, p. 257-265.

Second Day's Trip. Road Log from Snider Basin Ranger Station to Junction of Greys River and Little Greys River, p. 267-270.

Third Day's Trip. Road Log from Junction of the Greys River and Little Greys River to Green River Lakes by Way of Snake River Canyon, Hoback Canyon, and Cora-Green River Lakes Road, p. 271-280.

Exit Road Log. Pinedale to Farson, p. 281-282.

Exit Road Log. Farson to Lander, p. 282-283.

Exit Road Log. Farson to Rock Springs, p. 284-285.

2-3194. Matveevskaya, A. L. ON THE POSITION OF THE RUDNYY ALTAI IN THE STRUCTURAL PLAN OF THE SAYAN-ALTAI REGION: Akad. Nauk SSSR, Izvestiya, Geol. Ser., in translation, 1958, no. 11, p. 72-83, map, 4 secs., pub. June 1960, 20 refs.

The paper compares the geologic history of the Kolyvan-Tomsk and Irtysh-Zaysan (or Kalba) parts of the Ob-Zaysan Variscan geosynclinal system. On

the basis of this comparison and analysis of data on the structure and geologic history of the Rudnyy Altai and neighboring regions, the author concludes that the Rudnyy Altai consists of small block structures developed at the juncture of the Variscan geosynclinal system and the epi-Caledonian platform of the Gornyy Altai, which borders it in the E.--Auth.

2-3195. Ravich, M. G., and others. GEOLOGIC RECONNAISSANCE OF THE EASTERN PART OF THE MOUNTAINS IN QUEEN MAUD LAND, ANT-ARCTICA. Translated by Douglas Alverson: Internat. Geology Rev., v. 2, no. 10, p. 897-900, Oct. 1960, ref.

This reports on a [Soviet] 4-man geologic reconnaissance [Feb. 1959] of the eastern part of the mountains of Queen Maud Land, Antarctica. The German *Schwabenland* expedition of 1938-1939 had previously reported the so-called "oases" of ice-free lakes and dry land in the area. A description of the physiography and glaciology of the area includes a description of ice character, fissures, heights of shelf and continental ice fields, and the nature of the coastlines. The "oases" include bed-rock rolling lowlands, a nunatak zone, and block mountains. The geologic structure exhibits fault systems, block mountains, and some folding. Igneous and metamorphic rocks occur but no sedimentaries. Speculation on the development of known and probable mineral occurrences concludes that no great transportation difficulties would arise in mining and shipping ores.--D. C. Alverson.

2-3196. Hamilton, Warren B., and Philip T. Hayes. GEOLOGY OF TAYLOR GLACIER-TAYLOR DRY VALLEY REGION, SOUTH VICTORIA LAND, ANT-ARCTICA (In: U. S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B376-B378, 2 illus., 1960) ref.

The coastal belt of metasedimentary rocks is intruded on the W. side by a Cambrian (?) batholith composed of many plutons of varied granitic rocks. The flat-lying Beacon sandstone unconformably overlies these crystalline rocks and contains thick sills of strongly differentiated quartz diabase.--Auth.

2. GEOMORPHOLOGY

See also: Geologic Maps 2-3143, 2-3144, 2-3147; Areal and Regional Geology 2-3171 through 2-3176; Engineering geology 2-3591.

2-3197. Hunt, Charles B. SOME EXAMPLES OF GEOLOGIC FACTORS IN PLANT DISTRIBUTION (In: U. S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B390-B391, sec., diag., profile, 1960)

Gravel fans around the Death Valley, California, salt pan support xerophytes, whose distribution depends on ground conditions affecting the availability of vadose water. At the foot of the fans around the edge of the salt pan where ground water comes near the surface, the plants are phreatophytes, zoned with respect to the salinity of the water. There are no flowering plants on the salt pan, where the salinity of all the brines exceeds 6%.--Auth.

2-3198. Gold, L. W. THE CRACKING ACTIVITY IN ICE DURING CREEP: Can. Jour. Physics, v. 38,

no. 9, p. 1137-1148, 6 illus., 6 diags., graph, Sept. 1960, 14 refs.

Observations were made at one temperature on the cracks that form in ice during creep under constant compressive load. The ice had a hexagonal symmetry with respect to the grain boundaries. The load was applied perpendicular to the long axis of the grains. A piezoelectric crystal was used to detect the cracking activity in the ice.

Two stages of cracking were observed. The first occurred during the transient period of the creep, and the plane of these cracks tends to be parallel to the grain boundaries and to the direction of the stress. The rate at which these cracks formed decreased very markedly as the creep rate approached a constant value. Above a certain stress, the creep rate continuously increased with time. Under this condition the second stage of cracking was observed. These cracks tend to be more irregular in direction and to occur in planes that are at 45° to the applied stress.--Auth.

2-3199. Barnes, David F., and John E. Hobbie. RATE OF MELTING AT THE BOTTOM OF FLOAT-ING ICE (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B392-B394, 3 diag., 1960) 4 refs.

Studies at Lake Peters, Alaska, have shown that the rate of melting at the base of a fresh-water ice sheet is very slow. The thermal gradient causing it may be explained by an idealized theory of heat transfer involving solar radiation and water transparency.--Auth.

2-3200. Bader, Henri. THEORY OF DENSIFICATION OF DRY SNOW ON HIGH POLAR GLACIERS: U.S. Snow, Ice & Permafrost Research Establishment, Research Rept. 69, 8 p., diag., Jan. 1960, 3 refs.

The relations between rate of snow accumulation, snow density, snow age, and depth below the surface are formulated in terms of a compactive viscosity factor, which is assumed to be a function of only density and temperature, with parameters which will vary with the snow-type sequences of different climatic areas of high polar glaciers. The theory could be useful in an analysis of the data obtained from the large number of snow pits in Greenland, Ellesmere Island, and Antarctica.--Auth. summ.

2-3201. Benson, Carl S. PHYSICAL INVESTIGATIONS ON THE SNOW AND FIRN OF NORTHWEST GREENLAND, 1952, 1953, AND 1954: U.S. Snow, Ice & Permafrost Research Establishment, Research Rept. 26, 62 p., 24 illus., 2 maps (1 fold.), 5 profiles, 2 charts, 2 secs., 20 diags., 4 graphs, 7 fold. data sheets, 11 tables, Sept. 1959, 46 refs.

The Greenland ice sheet is a single, monomineralic rock formation. The bulk of the formation is metamorphic but it is covered by a thin (maximum thickness approx. 85 m. or 270 ft.) sedimentary veneer of snow and firn. This sedimentary member is perennial above the firn line; its history may be deciphered by the methods of classical stratigraphy and sedimentation.

During a 3-year period, 118 test sites (82 pits and 85 supplementary Rammonde profiles) were studied along a 300-mi. traverse, extending from 2,000 to 8,000 ft. above sea level in NW. Greenland. Measurements of temperature, density, ram hardness, and grain size were made on various firn strata at each pit.

The following diagenetically produced facies are recognized: 1) the ablation facies, which extends from the edge of the glacier to the firn line. The firn line is the highest elevation to which the snow cover recedes during the melt season. 2) The soaked facies, which becomes wet throughout during the melting season, extends from the firn line to the uppermost limit of complete wetting, the saturation line. The saturation line is the highest altitude at which the OC isotherm penetrates to the melt surface of the previous summer. 3) The percolation facies, which is subjected to localized percolation of melt water from the surface without becoming wet throughout, extends from the saturation line to the dry-snow line. Negligible soaking and percolation occur above the dry-snow line. 4) The dry-snow facies includes all of the glacier lying above the dry-snow line.

The saturation line is marked by discontinuities in temperature, density, and ram hardness data, and may also be located by examination of melt evidence in strata exposed on pit walls. It is as sharply

defined as the firn line; but the dry-snow line, although determined by the same methods, is a 10 to 20-mi. wide zone of transition.

The recognition of facies in glaciers provides the basis for a quantitative "geophysical classification" of glaciers because the altitude of the facies boundaries depends on environmental factors such as latitude, annual accumulation, air temperature, and exposure to the sun and wind. This "facies classification" allows greater resolution of glacier characteristics than does Ahlmann's "geophysical classification." In particular it permits quantitative subdivision of large glaciers which span the entire range of environments from temperate to polar.

Ahlmann's useful distinction between temperate and polar glaciers takes on new meaning in the light of glacier facies. Thus, a temperate glacier exhibits only the 2 facies below the saturation line, whereas one or both of the facies above the saturation line are present on polar glaciers.

Stratification results from variations in the conditions of deposition and subsequent diagenesis. Summer firn layers are coarser-grained and have lower density and hardness values than winter layers; they may also show evidence of surface-melt. The onset of fall and early winter is often identified by an abrupt increase in density and hardness with a decrease in grain size. Identification of seasonal layers gives a measure of annual accumulation; and the correlation of annual layers over a 320-mi. traverse has yielded a detailed picture of accumulation and precipitation. The data indicate that the ice sheet is nourished entirely by cyclonic storms and that precipitation in the region of investigation is about 5 times greater than that recorded at Thule. This difference is only partially due to local topography. The Thule records are believed to be in error because the standard precipitation gage is not adequate for measuring snow-storm precipitation.

Prevailing winds on the ice sheet are katabatic winds which are adiabatically warmed as they descend along the surface. This process controls the vertical component of the temperature gradient in the snow and firn, measured along the surface of the ice sheet. At elevations where melt is negligible, the main cause of densification of firn with depth is the load of overburden.

The depth-density curve is invariant with time as stated by Sorge's law. This makes it possible to treat the phenomenon of firn densification as a steady state situation with load as the only significant variable. The compaction of firn is caused by the elimination of pore space. It is assumed that the rate of elimination of pore space with increasing load is proportional to the amount of pore space present. This is expressed in the following equation: $\frac{dv}{dz} = -m(v - v_i)$, where $v = \frac{1}{\rho}$ = specific volume of firn (ρ = firn density), v_i = specific volume of ice = 1.09 cm.³/g., $\sigma = \int_z^{\infty} \rho dz$ = load at depth z below the snow surface. The parameter m may be regarded as a constant at a given location, but, in general, it is a function of temperature and the rate of accumulation. This equation provides a good fit to the observed data for depths greater than 10 m. below the snow surface.--Auth. summ.

2-3202. Griffiths, T.M. GLACIOLOGICAL INVESTIGATIONS IN THE TUTO AREA OF GREENLAND: U.S. Snow, Ice & Permafrost Research Establishment, Tech. Rept. 47, 63 p., 32 figs. incl. illus., maps, profiles, diags., 16 tables, Apr. 1960, 7 refs.

This report is primarily concerned with work accomplished during the 1956 field season, but observations and data obtained in 1954 and 1955 are included in many cases. Glaciological work done in connection with the ice tunnel at Camp TUTO is not covered in this report.

The 1956 program had the following objectives:

- 1) The continued collection of accumulation and ablation data on the Thule Ramp, on the P-Mountain Glacier, and at stations along the TUTO-Whitehorse Trail.
- 2) The establishment of a permanent base line in the Camp TUTO area which will serve for control of current and future projects in that area.
- 3) The determination of further ice movement velocities on the Thule Ramp, as a continuation of work begun there in 1954, and the adjustment of this ice movement network to the new base line established in 1956.
- 4) Continued measurements of the ice velocity network established in 1955 in the Blue Ice region.
- 5) The measurement of a triangulation network and establishment of photographic control stations on and near the edge of the ice from a point S. of Camp TUTO to the Moltke Glacier on the N. to be used for the compilation of an ice-edge map from photography to be procured by the U. S. Air Force.
- 6) The accumulation and interpretation of firm and ice temperature data from installed thermocouples in the Blue Ice Area, as a continuation of work done there in 1955, and along the TUTO-Whitehorse Trail at mile 7 and mile 20, as a continuation of work begun in 1954.
- 7) The gathering of other general information, including observation of ice-margin geomorphological phenomena and further general examination of the crevasse pattern in the P ue Ice and adjacent areas.--From auth. summ.

2-3203. Ewing, Maurice. **THE ICE AGES - THEORY:** Alberta Soc. Petroleum Geologists, Jour., v. 8, no. 7, p. 191-201, 2 maps, July 1960, 14 refs.

Late Cenozoic ocean floor sediment samples indicate an abrupt climatic change 11,000 years ago. Radiocarbon analyses dated the change indicated by cold to warm microfossils, O isotopes, and sediments in the North Atlantic.

Land change occurred earlier and gradually at the end of the Wisconsin stage. However, the Great Basin became arid 11,000 years ago, and the Great Lakes were depressed by glacial ice. Raised beaches on Arctic islands could have originated at the end of Wisconsin glaciation.

The present Arctic warming and thinning indicates the approach of another cold stage. The mechanics of an open Arctic sea developing and causing glacial deposits on lands to the S. are postulated.--G. L. Moyer.

2-3204. Stalker, Archibald. **SURFICIAL GEOLOGY OF THE RED DEER-STETTLE MAP-AREA, ALBERTA:** Canada, Geol. Survey, Mem. 306, 140 p., 14 illus., 20 maps (3 in pocket, incl. Map 1081A), 12 tables, 1960, 43 refs.

The Red Deer-Stettler area of central Alberta lies near the western limits of the region overrun by the great Laurentide ice sheets of the Pleistocene epoch. These glaciers were thin during most of their occupation of the area, and consequently their movements and effects were strongly influenced by the pre-existing topography. The mantle of various materials left by them has a marked effect on agriculture, water supply, and engineering.

This report deals with the surficial deposits laid

down by the glacier, by meltwater from the ice, and by contemporaneous and subsequent action of streams, lakes, and wind. It describes the origin and the physiographic forms of these deposits and stresses the marked effects of ice stagnation. Particular attention is given to gravel deposits, which are listed and described in detail, to the ground-water capabilities of the various surficial materials, and to the fill of the preglacial Red Deer valley which crosses the area. The report also portrays the general regional history during the Pleistocene epoch and, with aid of sketches, details the sequence of events during the final, or Wisconsin, deglaciation of the map-area.--Pref. by J.M. Harrison.

2-3205. Taylor, Richard Spence. **SOME PLEISTOCENE LAKES OF NORTHERN ALBERTA AND ADJACENT AREAS (REVISED):** Alberta Soc. Petroleum Geologists, Jour., v. 8, no. 6, p. 167-178, 185, 3 maps, June 1960, 45 refs.

Revision of a paper previously listed as GeoScience Abstracts 1-1889. The extent of Pleistocene lakes in northern Alberta and adjacent areas is only partly shown on the 1958 Glacial Map of Canada. A large body of literature reporting on field work of the past 75 years describes the deposits of lakes that covered much of the basins of the Peace and Athabasca rivers. A striking example is Miette Lake, over 80 mi. long, which lay across the continental divide in the headquarters of the Fraser and Athabasca rivers. Lakes of considerable size also existed in the western part of the basins of the North Saskatchewan and Churchill rivers, and in the Hay River basin. These basins were all complexly interconnected by spillways or accordant surfaces. Two large lakes (Peace and Tyrrell) covered more than 45% of the northern half of Alberta's surface at various times.--Auth.

2-3206. Lee, Hulbert A. **SURFICIAL GEOLOGY OF SOUTHERN DISTRICT OF KEEWATIN AND THE KEEWATIN ICE DIVIDE, NORTHWEST TERRITORIES:** Canada, Geol. Survey, Bull. 51, 42 p., 6 figs., map (in pocket), 13 pls., 1959, 20 refs.

The area provides clear indication of the position of the Keewatin ice divide, which stretched from Hudson Bay at 66°N. to a point 150 mi. inland at 61°N. The late age of the ice divide is clear from the consistent relationships of the trends of drumlinoid features to those of minor moraines and esker systems. The retreating ice margin of the S. and W. side of the ice divide was bordered by glacial lakes. The position of one of these lakes, here named glacial lake Kazan, and its spillway to the N., established the areas around the ice divide that first became free of glacial ice. The last glacial ice did not stagnate, but the ice margins withdrew, with minor forward pulsations. On both sides of the ice divide the earliest glacier flow was southerly, shown by rock inscribed features and erratics in the till contrasting with surface erratics. This southerly flow was both older than the ice divide and independent of it. Two types of minor moraines are recognized. Postglacial marine submergence is documented by lists and localities of marine shells and elevations on raised shorelines and modified drift. The highest former stand of the sea was about 613 ft., measured on cobble beach ridges near the present Hudson Bay coast and S. of the settlement of Chesterfield Inlet. Farther inland the elevation of the highest strandline is 560 ft., and marine shells

in the same general area are dated by radiocarbon at $6,975 \pm 250$ years old. Present elevations of the highest strandlines of the maximum inland incursion of the postglacial sea increase from N. to S. Buried peat at Rankin Inlet, 5,220 years old, is considered postglacial. The report is based on observations made on Operation Keewatin, the first helicopter operation of the Geological Survey of Canada.--Auth.

2-3207. Henderson, E.P. A GLACIAL STUDY OF CENTRAL QUEBEC-LABRADOR: Canada, Geol. Survey, Bull. 50, 50 p., 11 figs., 24 pls., 1960, 114 refs.

In the central areas of the Labrador plateau that were last occupied by Wisconsin ice there were marked shifts in the direction of flow on a regional scale, probably related to the declining hemicycle of the Wisconsin glaciation. Local ice movements in various directions followed at a late stage in the deglaciation of the region.

An oval area measuring over 200 mi. by 150 mi. in extent, centered near 55°N , 68°W ., was principally a region of erosion. Here glacial deposits are thin and glaciofluvial deposits scattered and fragmentary, while outside this area, where depositional conditions predominated, tills are thicker, and the great trunk eskers of the Labrador plateau radiate outwards in all directions.

At some time following deglaciation, a climate more severe than the present one modified some glacial deposits, particularly in places where very large nivation hollows were formed. It is considered that deglaciation was completed shortly before, or possibly even following, the thermal maximum. Radiocarbon dates suggest that deglaciation was completed approximately 6,000 years ago.--Auth.

2-3208. Karlstrom, Thor N.V. THE COOK INLET, ALASKA, GLACIAL RECORD AND QUATERNARY CLASSIFICATION (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B330-B332, chart, 1960) 13 refs.

The dated sequence of 5 major Pleistocene glaciations and Recent glacial advances is summarized and portrayed graphically. Comparisons with the midcontinental drift sequence, and with other independently dated chronologies, indicate that the standard classification of Pleistocene events is generally valid, so that the standard nomenclature needs only minor changes, not the drastic revision that some workers have proposed.--Auth.

2-3209. Richmond, Gerald M. CORRELATION OF ALPINE AND CONTINENTAL GLACIAL DEPOSITS OF GLACIER NATIONAL PARK AND ADJACENT HIGH PLAINS, MONTANA (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B223-B224, 1960) 4 refs.

Three alpine drifts, lacking local continental equivalents, are probably of Nebraskan, Kansan, and Illinoian age. Two tills of the alpine Bull Lake glaciation grade into continental drift correlated with the Iowan till of Iowa. Three tills of the alpine Pinedale glaciation are correlated with the classical Wisconsin glaciation of Illinois. The 2 older are related respectively to the Outer Continental and Lethbridge moraines in Alberta.--Auth.

2-3210. Lachenbruch, Arthur H. THERMAL CONTRACTION CRACKS AND ICE WEDGES IN PERMA-

FROST (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B404-B406, illus., 4 diagrs., 1960) 2 refs.

Ice wedges form from the freezing of surface water which percolates into recurring thermal contraction cracks in permafrost. A theoretical study suggests that rate of cooling is as important as amount of cooling in generating the thermal tension that causes cracking and that cracks penetrate well below the surficial tension that produces them.--Auth.

2-3211. Vasilev, Yu. M. EVIDENCE OF PERMAFROST PROCESSES IN QUATERNARY DEPOSITS OF THE NORTHERN CASPIAN REGION: Akad. Nauk SSSR, Izvestiya, Geol. Ser., in translation, 1958, no. 12, p. 89-90, pub. July 1960, 2 refs.

The author describes traces of permafrost in the middle and upper Quaternary deposits near Chernyy Yar village on the banks of the Volga river, in the northern part of the Caspian Sea region. Repeated findings of permafrost lenses in successive Quaternary deposits show that there were 4 interglacial stages. Similar findings were made in other parts of the Russian plain.--LC.

2-3212. Lachenbruch, Arthur H. CONTRACTION-CRACK POLYGONS (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B406-B409, 3 illus., 2 diagrs., 1960)

Columnar-basalt joints, mud-cracks, and ice-wedge polygons are all contraction-crack polygons, amenable to a single generalized theoretical treatment. Their size can be explained in terms of the stress-perturbation due to a single crack, and they may be classified according to whether or not their intersections are predominantly orthogonal. Evidently orthogonal polygons evolve by progressive subdivision, nonorthogonal ones by successive branching of cracks attaining high propagation velocities.--Auth.

2-3213. Hunt, Charles B., and A.L. Washburn. SALT FEATURES THAT SIMULATE GROUND PATTERNS FORMED IN COLD CLIMATES (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B403, diag., 2 secs., 1960)

Ground patterns in Death Valley that have resulted from deposition, solution, and cracking of salt are closely similar to those resulting from frost action in polar, subpolar, and alpine regions.--Auth.

2-3214. Segerstrom, Kenneth. EROSION AND RELATED PHENOMENA AT PARICUTIN IN 1957: U.S. Geol. Survey, Bull. 1104-A, 18 p., 10 illus., map (in pocket), 1960, 5 refs.

No appreciable compaction of the ash mantle of Parícutin volcano, Michoacán, Mexico, occurred during the period 1947-1957. In 1957 the floor of the crater was subsiding and there were nearly continuous rockslides from the oversteepened inner walls of the cone. Most of the area blocked to exterior drainage during 1943-1944 was still blocked in 1957, although flood channels had developed around the edge of the lava field. The rate of stripping of the ash mantle was markedly reduced by revegetation during the decade. A general increase

in ground-water flow that was noted in 1946 was even more apparent 11 years later. By 1957 plantlife had appeared at many places on the ash and lava flows from Parícutin, and even on the summit of the volcano. In the devastated area 5 years after cessation of Parícutin's erupted activity, 3 villages previously abandoned by townspeople and farmers had been resettled.--Auth.

2-3215. Schumm, Stanley A. THE SHAPE OF ALLUVIAL CHANNELS IN RELATION TO SEDIMENT TYPE: U.S. Geol. Survey, Prof. Paper 352-B, p. 17-30, 6 illus. on pl., 9 diags., table, 1960, 11 refs.

The weighted mean percent silt-clay in the channel and banks of stable alluvial stream channels is used as a parameter (M) descriptive of the physical characteristics of sediment. Silt-clay is defined as alluvial material smaller than 0.074 mm. As the percentage of silt and clay in banks and channel increases, the shape of stream channels expressed as a width-depth ratio (F) varies according to the equation, $F = 255 M^{-1.08}$. Neither mean annual discharge nor the mean annual flood significantly affects this relation in spite of the importance of discharge to the absolute width and depth of a channel.

Downstream changes in width and depth of a stream channel are greatly influenced by sediment type. As M increases downstream along a given river, the depth increases more rapidly and the width less rapidly with discharge than if M was constant, and width-depth ratio decreases. Conversely, as M decreases downstream the depth increases less rapidly and the width more rapidly with discharge than if M was constant, and width-depth ratio increases. The downstream changes in width, depth, and width-depth ratio along the Smoky Hill-Kansas River system is presented as an example of the importance of sediment type to stream regimen.

Unstable channels may be recognized by changes in width-depth ratio. In general, aggrading channels have a higher width-depth ratio than indicated by M ; whereas degrading channels have a lower width-depth ratio than indicated by M .--Auth.

2-3216. Jackson, W.H. DEPTH SOUNDINGS IN HEBGEN LAKE, MONTANA, AFTER THE EARTHQUAKE OF AUGUST 17, 1959: (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B221-B223, map, profile, 1960)

Depth soundings of Hebgen Lake after the earthquake of Aug. 17, 1959, detected a reversal in gradient of the pre-lake Madison River channel near Hebgen dam. Evidence of tilting of the lake floor was observed in parts of the lake but the soundings gave no indications of major faulting of the lake bottom.--Auth.

2-3217. Malde, Harold E. EVIDENCE IN THE SNAKE RIVER PLAIN, IDAHO, OF A CATASTROPHIC FLOOD FROM PLEISTOCENE LAKE BONNEVILLE (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B295-B297, 1960) 6 refs.

Rapid lowering of Lake Bonneville by erosion at Red Rock Pass, near Preston, discharged an enormous quantity of water into the Snake River plain, where canyons as deep as 500 ft. were cut in basalt, and boulder bars as much as 300 ft. thick were deposited in temporary lakes behind canyon constrictions.--Auth.

2-3218. Ray, Louis L. SIGNIFICANCE OF LOESS DEPOSITS ALONG THE OHIO RIVER VALLEY (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B211, 1960)

A stratigraphic succession of 4 Quaternary loess deposits occurs along the Ohio River valley between Louisville, Kentucky, and its mouth. The oldest, of Kansan age, is overlain by typical Loveland loess of Illinoian age. The 2 younger, the Farmdale and Peorian, are of Wisconsin age. Each loess deposit is genetically related to a valley train extending along the river.--Auth.

2-3219. Hack, John T. RELATION OF SOLUTION FEATURES TO CHEMICAL CHARACTER OF WATER IN THE SHENANDOAH VALLEY, VIRGINIA (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B387-B390, map, sec., table, 1960) 6 refs.

The stream waters of the region are divided into 4 types based on bicarbonate content, pH, and dissolved solids. Sinks in carbonate rocks are more abundant in areas recharged by waters of low pH draining clastic sediments than in areas in which all the streams drain carbonate rocks. The character of the stream waters is also one of the factors influencing the concentration of iron and manganese oxides in residual deposits.--Auth.

2-3220. Monroe, Watson H. SINKHOLES AND TOWERS IN THE KARST AREA OF NORTH-CENTRAL PUERTO RICO (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B356-B360, illus., 3 maps, 1960)

Sinkhole karst, consisting of closely spaced sinkholes as deep as 60 m., has formed on a sequence of alternating hard and soft beds of limestone. Tower karst, consisting of towers as high as 150 m. interspersed with shallow sinkholes, has formed on more homogeneous limestone.--Auth.

2-3221. Scheidegger, Adrian E. ANALYTICAL THEORY OF SLOPE DEVELOPMENT BY UNDERCUTTING: Alberta Soc. Petroleum Geologists, Jour., v. 8, no. 7, p. 202-206, 2 diags., table, July 1960, 3 refs.

A mathematical theory of the geomorphological development of mountain sides proposed in a previous paper by the writer is extended to the case where there is a river cutting away at the bottom of a slope. It is shown that the slope becomes steeper as time goes on so as to reach an asymptotic configuration. Further development occurs by more or less parallel slope recession.--Auth.

2-3222. Ahnert, Frank. THE INFLUENCE OF PLEISTOCENE CLIMATES UPON THE MORPHOLOGY OF CUESTA SCARPS ON THE COLORADO PLATEAU: Assoc. Am. Geographers, Annals, v. 50, no. 2, p. 139-156, 14 figs. incl. 11 illus., 2 maps, secs., June 1960, 17 refs.

The lack of information on the weather changes of the fairly recent past has led to much controversy as to the sequence of formation of the cuestas on the Colorado Plateau. A number of pluvial periods have existed in the Pleistocene and these and their dry inbetween periods shaped a landform that shows varying signs of their passing. Successive landslides in varying states of dissection and successive

stream deposits may be used to date these variances in rainfall; this information may also possibly be applied to other areas throughout the American Southwest.--B.C. Schreiber.

2-3223. Lewis, Peirce F. **LINEAR TOPOGRAPHY IN THE SOUTHWESTERN PALOUSE, WASHINGTON-OREGON:** Assoc. Am. Geographers, Annals, v. 50, no. 2, p. 98-111, 10 figs. incl. 4 illus., 3 maps, June 1960, 17 refs.

Several possible reasons have been presented for the origin of the linear topography in the SW. Palouse. Each in turn was examined by the author and its values weighed. It was obvious that only a wind-blown loess deposit, wind oriented and controlled, could have created the linearity observed. Further, that critical grain sizing as determined by the carrying power of winds of varying velocities controlled the areal extent of the linearity as well. The winds of highest velocity are most consistently unidirectional while those of lower velocities are variable. As a consequence there is a marked drop-off in linearity at the points where the carrying power of the winds was diminished sufficiently. This region is present and completes the presentation of a "wind-shadow" origin of these hills.--B.C. Schreiber.

2-3224. Moore, George W. **RECENT EUSTATIC SEA-LEVEL FLUCTUATIONS RECORDED BY ARCTIC BEACH RIDGES** (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B335-B337, 2 profiles, 1960) 3 refs.

The dates of beach ridges on the northwestern coast of Alaska, as estimated by archeological and

radiocarbon methods, appear to indicate that sea level rose somewhat irregularly during the last 5,000 years and reached its highest position in the 19th century.--Auth.

2-3225. Georgiev, Milan. **THE SAMOKOVSKA VALLEY.** Prepared by U.S. Joint Publications Research Service: Internat. Geology Rev., v. 2, no. 9, p. 811-815, 5 illus., map, Sept. 1959.

Bulgaria's largest dam, "Stalin" is located in the Samokovska valley. The average altitude of the valley is 950 m., its area 185 sq. km. The area is generally one of graben development modified by extensive erosion of surrounding mountains and Pliocene through Quaternary deposition of alluvium. Extensive erosion control measures will be required to prevent early silting up of the reservoir behind Stalin dam.--M. Russell.

2-3226. [K'o-hsueh Ch'u-pan-she]. **NATURAL GEOGRAPHIC DATA OF NORTH CHINA, GEOMORPHOLOGY.** Prepared by U.S. Joint Publications Research Service: Internat. Geology Rev., v. 2, no. 8, p. 705-725, 10 maps, 3 secs., Aug. 1960, 28 refs.

N. China is divided into 3 major geomorphic regions. Thick deposits of loess are a primary feature of the area; its distribution, age, and relation to other geologic formations are given. The Variscan and Himalayan orogenies influenced the paleogeography of the region greatly. The Huang Ho deposits great amounts of silt annually; efforts to control this river constitute a continuing major effort.--M. Russell.

3. STRUCTURAL GEOLOGY

See also: Areal and Regional Geology 2-3161 through 2-3165, 2-3174, 2-3183, 2-3188, 2-3194; Geophysics 2-3345, 2-3353, 2-3356, 2-3360, 2-3390, 2-3411; Igneous and Metamorphic Petrology 2-3490, 2-3495; Sedimentary Petrology 2-3514; Mineral Deposits 2-3566, 2-3567, 2-3569, 2-3573.

2-3227. Belousov, V.V. **ON CERTAIN RESULTS AND PROSPECTS OF TECTONOPHYSICAL INVESTIGATIONS:** Akad. Nauk SSSR, Izvestiya, Geol. Ser., in translation, 1958, no. 11, p. 1-14, 9 figs. incl. illus., secs., diags., pub. June 1960, 32 refs.

In Soviet terminology, tectonophysics is a science concerned only with the study of the physical mechanism of tectonic deformations. The author founded the first Soviet laboratory of tectonophysics, which at present forms a part of the Section of Geodynamics, Institute of Physics of the Earth, Academy of Sciences, U.S.S.R. This laboratory has reproduced on various models the different tectonic deformations observed on the earth, and these experiments have defined the causes of the deformation of the earth's crust. Until recently, scientists thought that the fold formation during a general process of crumpling of the crust occurred on a planetary scale. Laboratory experiments, however, have shown that the fold formation could be considered as a peculiar reaction of the bedded strata of the crust to the differentiated vertical movements of the separate blocks of the crust. This is why the folding always occurs in the geosynclinal zones. The laboratory's experiments with models of various materials showed that the fold formation depended on specific local conditions, which

could be thoroughly studied by recreating them artificially in models. The author studies the results of these researchers and comes to the conclusion that the method of tectonophysics is an important addition to the strictly geological method of study. Further systematic development of this branch of science is recommended.--LC.

2-3228. Moore, James G. **CURVATURE OF NORMAL FAULTS IN THE BASIN AND RANGE PROVINCE OF THE WESTERN UNITED STATES** (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B409-B411, diag., table, 1960) 6 refs.

The main normal faults bounding tilted fault-block ranges are generally concave in plan toward their downthrown side. This fact together with inferred flattening of faults with depth suggests that most basin-range normal faults are doubly concave toward their downthrown side.--Auth.

2-3229. Smith, George I. **TIME OF THE LAST DISPLACEMENT ON THE MIDDLE PART OF THE GARLOCK FAULT, CALIFORNIA** (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B280, 1960) 3 refs.

Tufa deposited on a fault scarp during a high stand of Searles Lake, California, indicates that the last major displacement along the central part of the Garlock fault occurred more than 50,000 years ago.--Auth.

2-3230. Drewes, Harald D. ORIGIN OF THE AMARGOSA THRUST FAULT, DEATH VALLEY AREA, CALIFORNIA: A RESULT OF STRIKE-SLIP FAULTING IN TERTIARY TIME (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B268-B270, 3 diags., 1960) 6 refs.

The Amargosa thrust fault may be a rootless structure formed by repeated rupture within a large block bounded by recurrently shifting major strike-slip faults. Similar rootless, but not gravity-slid, thrust faults may occur in the eastern part of the Basin and Range province.--Auth.

2-3231. Green, Gordon W., and Charles B. Hunt. OBSERVATIONS OF CURRENT TILTING OF THE EARTH'S SURFACE IN THE DEATH VALLEY, CALIFORNIA, AREA (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B275-B276, map, table, 1960) ref.

Observations made with the liquid-level tiltmeter since May 1958 in the Death Valley, California, area indicate that certain fault blocks are being slowly tilted toward the E. at present. The direction and extent of observed tilting agree with known geologic structure and movements in the recent geologic past.--Auth.

2-3232. Pakiser, Louis C. VOLCANISM IN EASTERN CALIFORNIA - A PROPOSED ERUPTION MECHANISM (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B411-B414, 4 maps, 1960) 7 refs.

Geophysical and geologic evidence suggests that the volcanic rocks along the eastern front of the Sierra Nevada were erupted from regions of relative tension or stress relief in offsets of a major left-lateral en echelon shear zone. This shear zone may continue northward into the southern Cascades.--Auth.

2-3233. Tweto, Odgen. PRE-ORE AGE OF FAULTS AT LEADVILLE, COLORADO (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B10-B11, chart, secs., 1960) 2 refs.

Intrusive relations indicate that most of the faults in the Leadville district were in existence at the time porphyries of several varieties were emplaced. As the porphyries are older than the ore, the same is true of the faults, although many underwent post-ore movement.--Auth.

2-3234. Hawley, C.C., W.N. Sharp, and Wallace R. Griffiths. PRE-MINERALIZATION FAULTING IN THE LAKE GEORGE AREA, PARK COUNTY, COLORADO (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B71-B73, map, 1960)

The Precambrian rocks which underlie most of the area are traversed by lineaments that strike NNW. These lineaments are due, at least in part, to fault fissures containing small amounts of Be. This, together with greisenization along the faults resembling that associated with the area's replacement-type Be deposits, indicates that the faults are older than the mineralization.--Auth.

2-3235. Drewes, Harald D. BEDDING-PLANE THRUST FAULTS EAST OF CONNORS PASS, SCHELL CREEK RANGE, EASTERN NEVADA (In: U.S. Geo-

logical Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B270-B272, map, 2 secs., 1960) 4 refs.

The Paleozoic rocks E. of Connors Pass are now believed to be affected by many bedding-plane thrust faults that have cut out tens to thousands of feet of an otherwise normal sequence. This contradicts the previously advocated view that an overturned section has been shoved over the Prospect Mountain quartzite along a decollement thrust fault.--Auth.

2-3236. Reed, John C., Jr., and Bruce H. Bryant. A MAJOR TOPOGRAPHIC LINEAMENT IN WESTERN NORTH CAROLINA AND ITS POSSIBLE STRUCTURAL SIGNIFICANCE (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B195-B197, map, 1960) 9 refs.

In the Table Rock quadrangle, retrogressively metamorphosed rocks are exposed along a topographic lineament in line with the Brevard belt to the SW. and with the Yadkin River valley to the NE. This lineament appears to mark a major fault of undetermined nature separating rocks of the inner Piedmont from rocks of different aspect in the Blue Ridge.--Auth.

2-3237. Staatz, Mortimer H. THE REPUBLIC GRABEN, A MAJOR STRUCTURE IN NORTHEASTERN WASHINGTON (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B304-B306, map, 1960)

The Republic graben in the Okanogan Highlands just S. of the Canadian border is 4 to 10 mi. wide, about 50 mi. long, and trends NNE. It was formed between early and middle Tertiary time as a result of slow subsidence that followed the extrusion of volcanic material. Because of subsequent erosion the graben now has little topographic expression.--Auth.

2-3238. Pierce, William G. THE "BREAK-AWAY" POINT OF THE HEART MOUNTAIN DETACHMENT FAULT IN NORTHWESTERN WYOMING (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B236-B237, 3 secs., 1960) ref.

Discovery of the northwestern limit of the Heart Mountain fault near the NE. corner of Yellowstone Park permits determination of its parameters. Horizontal movement on the fault increased southeastward, from zero at the break-away point near the Park to 30 mi. at the SE. end of the fault, 65 mi. away.--Auth.

2-3239. Briggs, Reginald P., and Maurice H. Pease, Jr. COMPRESSIONAL GRABEN AND HORST STRUCTURES IN EAST-CENTRAL PUERTO RICO (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B365-B366, map, 1960)

Regional compression has caused large-scale transcurrent faulting in E.-central Puerto Rico. Graben and horsts have formed as a result of movement along these faults. The apparent stratigraphic offset of these structural features locally exceeds 2,000 m.--Auth.

2-3240. Glover, Lynn, 3d, and Peter H. Mattson. SUCCESSIVE THRUST AND TRANSCURRENT FAULT-

ING DURING THE EARLY TERTIARY IN SOUTH-CENTRAL PUERTO RICO (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B363-B365, map, 2 secs., 1960) ref.

Early compression or gravity gliding toward N. 20°E., indicated by folds and thrust faults that trend N. 70°-80°W., was followed by compression toward N. 80°E., as indicated by left-lateral transcurrent faults that trend N. 70°W. and cut the folds and thrust faults.--Auth.

2-3241. Joesting, Henry R., and James E. Case. SALT ANTICLINES AND DEEP-SEATED STRUCTURES IN THE PARADOX BASIN, COLORADO AND UTAH (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B252-B256, 3 maps, 1960) 10 refs.

Regional magnetic and gravity anomalies, indicative of deep-seated structural or lithologic boundaries, coincide with some of the larger salt anticlines of the Paradox basin. The deepest parts of the basin, in which the larger salt anticlines are found, are bounded on the NE. by the uplifted Uncompahgre plateau and on the SW. by buried basement ridges. A broad basement platform probably underlies the La Sal Mountains.--Auth.

2-3242. Elston, Donald P., and E.R. Landis. PRE-CUTLER UNCONFORMITIES AND EARLY GROWTH OF THE PARADOX VALLEY AND GYPSUM VALLEY SALT ANTICLINES, COLORADO (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B261-B265, 2 maps, 1960) 13 refs.

The cores of the Paradox Valley and Gypsum Valley salt anticlines are unconformably overlain by thin formations of Middle and Late Pennsylvanian and Permian age. Growth of the salt structures began in Middle Pennsylvanian time and it probably was maintained in later Pennsylvanian time by repeated tectonic pulses.--Auth.

2-3243. Drake, Avery A., Jr., Robert E. Davis, and Donald C. Alvord. TACONIC AND POST-TACONIC FOLDS IN EASTERN PENNSYLVANIA AND WESTERN NEW JERSEY (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B180-B181, 1960) 9 refs.

Taconic folds in this region are overturned to the NW., and are further complicated by flow cleavage that has been folded by slip cleavage, and by thrust faulting. The Silurian and Devonian rocks are characterized by asymmetric folds with short SE. limbs. These folds and the younger structures in the pre-Silurian rocks were formed contemporaneously, probably during the Appalachian orogeny.--Auth.

2-3244. Keefer, William R. PROGRESSIVE GROWTH OF ANTICLINES DURING LATE CRETACEOUS AND PALEOCENE TIME IN CENTRAL WYOMING (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B233-B236, 3 maps, sec., 1960) 5 refs.

Structural features along the margins of the Wind River basin began to form in Late Cretaceous time and grew at a moderate rate almost continuously through the Paleocene. Thick conformable deposits

accumulated in the trough areas whereas along the flanks of the rising folds the equivalent sedimentary units are much thinner and are commonly separated by unconformities.--Auth.

2-3245. Zietz, Isidore. CONFIGURATION OF THE 10N PLUTON, THREE FORKS, MONTANA (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B229-B230, map, 2 profiles, 1960)

A detailed aeromagnetic survey reveals that the extent of the upper surface of the 10N pluton is much greater than its exposures at the surface. Calculations show that the pluton may be bottomed at a depth of several thousand feet, which implies that in this area the Lombard thrust fault, exposed to the E., is younger than the intrusive and cuts it off at some such depth.--Auth.

2-3246. de Mille, George. THE ELBOW STRUCTURE OF SOUTH-CENTRAL SASKATCHEWAN: Alberta Soc. Petroleum Geologists, Jour., v. 8, no. 5, p. 154-162, 5 maps, 2 secs., May 1960, 6 refs.

The Elbow structure in S.-central Saskatchewan was discovered during a search for oil. It consists of a symmetrical dome in Mesozoic rocks beneath which reposes a cylindrical mass of broken Paleozoic rock. There is evidence of some broken rock having been displaced stratigraphically upward by violent movement, possibly explosive in nature. The structure is marked by a positive gravity anomaly which reflects the upward displacement of the disturbed mass and the dome formed in Mesozoic strata.

The structure apparently experienced 2 periods of activity. The first was post-Mississippian in age and explosive in nature; the other, probably Tertiary in age and nonviolent, resulted in the uplift of the Mesozoic and Tertiary strata to form a dome. The nature of the second movement is unknown but it is believed to be related to the Laramide orogeny.

A similar feature, the Gilroy structure, lies about 4 mi. S. of Elbow. It is not indicated by a gravity anomaly. Both structures are considered to be cryptovolcanoes.--Auth.

2-3247. Luedke, Robert G., and Wilbur S. Burbank. RING-FRACTURED BODIES IN THE SILVERTON CALDERA, COLORADO (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B13, 1960)

Late volcanic activity is manifested in the Silver-ton district by igneous intrusion, faulting, and fracturing. Several columnar bodies within the caldera, each about a mile in diameter, are outlined by ring fractures and faults, which are superimposed upon preexisting caldera structures and were probably formed by localized magmatic pressures at depth.--Auth.

2-3248. Dietz, Robert S. METEORITE IMPACT SUGGESTED BY SHATTER CONES IN ROCK: Science, v. 131, no. 3416, p. 1781-1784, 3 illus., June 17, 1960, 13 refs.

Shatter cones, related brecciation, and shatter and chaotic circularly disturbed structures have been laid to possible meteoric impact. These structures have previously been ascribed to volcanic origins but are now considered shock wave reactions of nonvolcanic impacts, and possibly extraterrestrial. Three

possible sites were visited and identified; however Meteor Crater yielded no similar structures. On the other hand, a lake of meteoric origin did yield the 8th known locality for the distinctive shatter cones.--B.C. Schreiber.

2- 3249. Hess, H.H. THE AMSOC HOLE TO THE EARTH'S MANTLE: Am. Geophys. Union, Trans., v. 40, no. 4, p. 340-345, 4 figs., Dec. 1959, 10 refs.

A project to drill to and through the Mohorovičić discontinuity, dubbed the Moho, is reviewed and strongly supported. Hoped-for results include: measurements on the density, composition, bulk, mineral phases, radioactivity, age, isotopes of Pb and total Pb and U of material below the Moho, and collection of any gases or liquids found there; nature of the layer immediately above the Moho; a detailed study of the sedimentary column above the Moho; and measurement of the thermal, seismic-velocity, magnetic, and electric properties of the material through which the hole passes. It is expected to find, from top downward: 1) layer 1 of unconsolidated sediments, 2) layer 2 of consolidated sediments, 3) layer 3 of serpentinized peridotite. Further, it is expected that Ringwood's model will be correct and that layers 1 and 2 will be very incomplete at the site chosen.--M. Russell.

2- 3250. Deutsch, E.R. FIRST-ORDER TECTONICS OF NORTH AMERICA, A REVIEW: Alberta Soc. Petroleum Geologists, Jour., v. 8, no. 8, p. 228-232, map, diag., Aug. 1960, 6 refs.

A symposium on the structure of western North America was arranged by the Alberta Society of Petroleum Geologists, May 25, 1960, to mark the visit of Prof. S. Warren Carey to Calgary.

An "orocline" is "an orogenic belt with a change in trend interpreted as an impressed strain." Traditionally, the bend was always "thought to have been there." Interpretation of oroclines, i.e., the process of straightening them out leads to acceptance of the hypothesis of continental drift. Carey's results have been partly confirmed by paleomagnetism and ancient wind directions.

Carey's tectonic pattern of North America is associated with a main shear couple resulting in a primary inverted "S"-shaped trend. Each part of the pattern was named to express the dilation on the Mexican end, the shear in the Basin and Range middle, and the compression on the N. end in the Rocky Mountain Trench.

Relative horizontal displacement between North America and Europe is suggested by failure of pole wandering curves to coincide.--G.L. Moyer.

2- 3251. Lustig, E.N. ON THE HYPOTHESIS OF THALASSOGENESIS AND ON THE MOVEMENT OF BLOCKS IN THE EARTH'S CRUST: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1959, no. 11, p. 1096-1101, chart, sec., 2 diag., pub. Aug. 1960, 22 refs.

Any hypothesis assuming an expansion of the oceans because of the erosion of the continents is untenable. The facts which have been advocated in defense of such hypotheses admit different explanations just as well. The mobility of the junctures between blocks of the continental crust does not prove that the blocks themselves are mobile.--Auth.

2- 3252. Andreeva, I.B., and G.B. Udintsev. BOTTOM STRUCTURE OF THE SEA OF JAPAN, FROM THE "VITYAZ" EXPEDITION DATA: Akad. Nauk SSSR, Izvestiya, Geol. Ser., in translation, 1958, no. 10, p. 1-15, 10 figs. incl. map, sec., diag., graphs, 2 tables, pub. June 1960, 23 refs.

English translation of GeoScience Abstracts 1-642.

2- 3253. Goodman, A.J. REVIEW OF SOME HYPOTHESES ON MOUNTAIN BUILDING: Alberta Soc. Petroleum Geologists, Jour., v. 8, no. 8, p. 215-227, 7 diag., Aug. 1960, 34 refs.

This paper reviews recent concepts of mountain building. Bucher's ideas and experiments, representing the contraction viewpoint, with emphasis on horizontal stress, are considered. Belousov's contention that vertical stress is the prime factor in mountain building is also mentioned together with the views of others who challenge the over-all décollement idea as exemplified in Buxtorf's Jura interpretation. Carey's revolutionary concepts, which include an expanding earth, continental drift, and the interlocking on a global scale of all major tectonics, are given consideration and related to earlier concepts by others.--Auth.

2- 3254. Arndt, Harold H., and Gordon H. Wood, Jr. LATE PALEOZOIC OROGENY IN EASTERN PENNSYLVANIA CONSISTS OF FIVE PROGRESSIVE STAGES (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B182-B184, map, secs., 1960) ref.

The structures resulting from the Appalachian orogeny in the anthracite region of Pennsylvania increase in complexity southeastward. An orderly pattern of structural features suggests a deformational progression divisible into structural stages based on increasing complexity. Areas of extreme deformation appear to have passed through each of the several preceding stages of deformation.--Auth.

2- 3255. Clark, Lorin D. EVIDENCE FOR TWO STAGES OF DEFORMATION IN THE WESTERN SIERRA NEVADA METAMORPHIC BELT, CALIFORNIA (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B316-B318, illus., map, 1960) 3 refs.

In the western part of the Sierra Nevada, 2 distinct stages of deformation have affected metamorphic rocks throughout a belt more than 200 mi. long and 40 mi. wide. The first resulted in folds that plunge less than 20°, the second in large faults and in minor folds and b-lineations that plunge more steeply than 60°.--Auth.

2- 3256. Hamilton, Warren B. STRUCTURE IN THE BIG MARIA MOUNTAINS OF SOUTHEASTERN CALIFORNIA (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B277, map, secs., 1960)

The SE. part of the Big Maria range consists mainly of thin, distinctive, metasedimentary Paleozoic(?) formations, which have been thoroughly sheared and isoclinally folded. These rocks are cut by thrust faults that are directed northeastward, and some of these faults were themselves isoclinally folded. The metasedimentary rocks are underlain by plutonic Precambrian(?) rocks, which also were

thrust faulted and locally underwent retrograde metamorphism. These, and also the metasedimentary rocks, are cut by later plutonic rocks which are normally faulted.--Auth.

2-3257. Gilluly, James. STRUCTURE OF PALEOZOIC AND EARLY MESOZOIC ROCKS IN THE NORTHERN PART OF THE SHOSHONE RANGE, NEVADA (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B265, 1960)

Rocks of Cambrian to Devonian age underwent very complex deformation, dominated by the Roberts thrust, probably in Mississippian time. Later deformation also affected Mesozoic rocks.--Auth.

2-3258. Houser, Frederick N., and Forrest G. Poole. STRUCTURAL FEATURES OF PYROCLASTIC ROCKS OF THE OAK SPRING FORMATION AT THE NEVADA TEST SITE, NYE COUNTY, NEVADA, AS RELATED TO THE TOPOGRAPHY OF THE UNDERLYING SURFACE (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B266-B268, map, 1960) ref.

At the Nevada Test Site, the pyroclastic Oak Spring formation, of Tertiary age, contains anticlines and synclines that were formed by its deposition over ridges and in valleys on an erosion surface with as much as 1,600 ft. of relief.--Auth.

2-3259. Minard, James P., and James P. Owens. DIFFERENTIAL SUBSIDENCE OF THE SOUTHERN PART OF THE NEW JERSEY COASTAL PLAIN SINCE EARLY LATE CRETACEOUS TIME (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B184-B186, map, diag., 2 tables, 1960)

Differential subsidence is indicated by thickening of formations down dip and along strike, and by a progressive change in strike of the formations. Each younger formation strikes more easterly than the one below it.--Auth.

2-3260. Bezborodov, R.S. STRUCTURAL CHARACTERISTICS OF THE SOUTHERN LIMB OF THE BELOMECHET SYNCLINE IN NORTHERN CAUCASUS: Akad. Nauk SSSR, Izvestiya, Geol. Ser., in translation, 1958, no. 11, p. 100-103, map, 2 secs., pub. June 1960, 5 refs.

The study of core samples and of the diagrams of bore holes drilled in the region of the southern edge of the Belomechetskaya syncline (N. Caucasus) showed that this region was subjected to repeated sinkings in the Lower and Middle Jurassic periods and that its steep southern edge borders on a tectonic seam, along

which movements occurred up to the Upper Jurassic period. The whole North Caucasian depression was composed in the Liassic and Middle Jurassic times of 2 independent, northern and southern depressions; the Belomechetskaya syncline formed the northern depression. Both depressions were divided by an anticlinal elevation of the Hercynian foundation.--LC

2-3261. Bogdanov, A.A. BASIC FEATURES OF THE PALEOZOIC STRUCTURE OF CENTRAL KAZAKHSTAN. Translated by Research International: Internat. Geology Rev., v. 2, no. 9, p. 781-810, 6 maps, diag., Sept. 1960, 114 refs.

Within the Paleozoic massif of central Kazakhstan, 2 zones can be distinguished, the Caledonian to the SW., W., and N., and the Variscan zone to the E. and SE. These 2 major zones differ in their middle and upper Paleozoic sections, their magmatic activity, and the nature of their tectonic disruptions.--Auth.

2-3262. Shafiro, Ya. Sh. NEW DATA ON THE TECTONICS OF NORTHERN ERGHENI: Akad. Nauk SSSR, Izvestiya, Geol. Ser., in translation, 1958, no. 10, p. 36-43, 3 maps, profile, pub. June 1960, 8 refs.

English translation of GeoScience Abstracts 1-646.

2-3263. Solov'ev, A.V. A TECTONIC CLASSIFICATION OF SAKHALIN: Akad. Nauk SSSR, Izvestiya, Geol. Ser., in translation, 1958, no. 12, p. 1-6, 4 maps, pub. July 1960, 7 refs.

The author disputes the validity of opinions expressed by S.N. Alekseychik and K.I. Gnedin, who consider the structure of the entire Sakhalin area during Tertiary time as a foreland district adjacent to a geosynclinal trough E. of the present island. Three tectonic zones on the island are identified by the writer, based on studies and analyses of folding in many locations on Sakhalin. These represent geosynclinal, intermediate, and platform provinces present during Tertiary time.--Auth.

2-3264. Hamilton, Warren B. NEW INTERPRETATION OF ANTARCTIC TECTONICS (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B379-B380, 1960) 3 refs.

The continuous system of high mountains crossing Antarctica near the South Pole may mark the site of metamorphism and batholithic intrusion during Cambrian time. Rock types, structures, and the available fossil and radiometric age determinations accord with this and conflict with the conventional theory that the mountains are a horst of rocks of an ancient shield.--Auth.

4. STRATIGRAPHY AND HISTORICAL GEOLOGY

See also: Areal and Regional Geology 2-3156, 2-3157, 2-3158, 2-3177 through 2-3180, 2-3187; Geomorphology 2-3208, 2-3209, 2-3218; Structural Geology 2-3242, 2-3244, 2-3259; Paleontology 2-3320; Geochemistry 2-3452; Igneous Petrology 2-3499; Sedimentary Petrology 2-3506, 2-3510, 2-3517; Engineering Geology 2-3589.

2-3265. Alvarez, Manuel, Jr. VERSION CASTELLANA DE LA REDACCION PRELIMINAR DEL CODIGO ESTRATIGRAFICO [SPANISH TRANSLATION

OF THE PRELIMINARY VERSION OF THE STRATIGRAPHIC CODE]: Soc. Geol. Mexicana, Bol., v. 22, no. 1, p. 5-32, 1959.

This Spanish version of the Stratigraphic Code prepared by the Committee on Lithostratigraphic Units of the American Commission on Stratigraphic Nomenclature has a short introduction by the author urging Mexican geologists to voice suggestions on the

ode via their representatives on the commission.--
van Vloten.

-3266. Nalivkin, D.V. THE STUDY OF FACIES:
BASIC PRINCIPLES. Translated by Peter A. Florek:
Internat. Geol. Rev., v. 2, no. 9, p. 772-780,
Sept. 1960, 12 refs.

The concept of facies is attributed to the Swiss
geologist, Gressly. It is definable in terms of a
uniform portion of a land surface or sea floor, with
definite implications of geography. Different facies
in the Black Sea and Caucasus are cited. Gross uni-
formity of lithology and biocoenose are implied with-
in facies. The work of numerous Russian and Amer-
ican geologists in facies studies is reviewed. A
classification of facies is proposed in which the con-
cept of servia and nimia is introduced.--M. Russell.

-3267. White, Walter S., and James C. Wright.
LITHOFACIES OF THE COPPER HARBOR CON-
GLOMERATE, NORTHERN MICHIGAN (In: U.S.
Geological Survey. Geological Survey Research
1960: Its: Prof. Paper 400-B, p. B5-B8, map, sec.,
1960)

The conglomerate facies [late Keweenaw], con-
sisting of fans interstratified with lava, was de-
posited by northward flowing streams along the south-
ern margin of the Lake Superior basin. A redder
finer-grained sandstone facies, locally deposited by
southward-flowing currents, probably represents a
transition to alluvial-plain or standing-water deposits
in the center of the basin.--Auth.

-3268. Keller, B.M., and others. PALEOZOIC
OF THE REGION WEST OF LAKE BALKHASH NEAR
THE VILLAGE OF MYNARAL: Akad. Nauk SSSR,
Izvestiya, Geol. Ser., in translation, 1958, no. 10,
p. 44-55, 5 figs. incl. 2 maps, secs., pub. June
1960, 9 refs.

English translation of GeoScience Abstracts 1-651.

-3269. Irwin, William P. RELATIONS BETWEEN
ABRAMS MICA SCHIST AND SALMON HORNBLENDE
SCHIST IN WEAVERVILLE QUADRANGLE, CALI-
FORNIA (In: U.S. Geological Survey. Geological
Survey Research 1960: Its: Prof. Paper 400-B, p.
B315-B316, map, 1960) 2 refs.

In the southern part of the Klamath Mountains
province, California, the Abrams mica schist
structurally overlies the Salmon hornblende schist
and is believed to be younger than the Salmon, rather
than older as previously thought.--Auth.

-3270. Neuman, Robert B. PRE-SILURIAN STRA-
TIGRAPHY IN THE SHIN POND AND STACYVILLE
QUADRANGLES, MAINE (In: U.S. Geological Survey.
Geological Survey Research 1960: Its: Prof. Paper
400-B, p. B166-B168, map, 1960) 4 refs.

Brachiopods and other fossils at the base of the
volcanic sequence in the Shin Pond quadrangle, and
traptolites at its top in the Stacyville quadrangle,
indicate that this sequence is probably of Middle
Ordovician age. The underlying quartzite and slate
formation (Grand Falls formation of Ruedemann and
Smith) is altogether different lithologically, and
more complex in structure. The contact between the
two thus appears to be an angular unconformity that
may represent an episode of folding.--Auth.

2-3271. Grigorev, V.N., and M.A. Semikhatov.
THE AGE AND ORIGIN OF THE SO-CALLED "TIL-
LITES" OF THE NORTHERN PART OF THE YENI-
SEY RANGE: Akad. Nauk SSSR, Izvestiya, Geol.
Ser., in translation, 1958, no. 11, p. 34-45, 3 illus.,
map, sec., pub. June 1960, 23 refs.

The authors describe peculiar boulder-pebble
argillites which are widely distributed in the northern
part of the Yenisey range and are usually called "til-
lites," and conclude that they are Lower Cambrian
conglomerates formed at the base of an uplift (cordil-
lera) and transported over a considerable distance by
subaqueous slumping.--Auth.

2-3272. Palmer, Allison R. IDENTIFICATION
OF THE DUNDERBERG SHALE OF LATE CAM-
BRIAN AGE IN THE EASTERN GREAT BASIN (In:
U.S. Geological Survey. Geological Survey Re-
search 1960: Its: Prof. Paper 400-B, p. B289-B290,
chart, 1960) 4 refs.

The Dunderberg shale at its type locality in the
Eureka district, Nevada, is a unit of interbedded
shale and limestone, probably faulted at its base,
that contains trilobites of the *Dunderbergia* and
Elvinia zones. A full exposure of the Dunderberg
NE. of Eureka, near Cherry Creek, Nevada, con-
tains trilobites of the *Aphelaspis*, *Dunderbergia*,
and *Elvinia* zones.

The so-called "Dunderberg shale" of western
Utah contains only trilobites of the *Elvinia* zone.
An older shaly unit, separated from the so-called
"Dunderberg shale" by a carbonate unit, contains
trilobites of the *Aphelaspis* and *Dunderbergia* zones.
The "Dunderberg shale" of western Utah is better
called the Corset Spring shale.--Auth.

2-3273. McLean, Douglas D. DEADWOOD AND
WINNIPEG STRATIGRAPHY IN EAST-CENTRAL
SASKATCHEWAN: Saskatchewan, Dept. Mineral
Resources, Rept. no. 47, 37 p., 13 figs., 5 pls.,
1960, 26 refs.

The Deadwood and Winnipeg formations in E.-
central Saskatchewan comprise a sequence of largely
arenaceous and argillaceous strata ranging in age
from Upper Cambrian to Upper Ordovician. The
Deadwood formation rests unconformably on the Pre-
cambrian surface and is separated by another major
unconformity from the overlying Winnipeg formation,
which is in turn conformably overlain by dolomitic
limestones of the Red River formation.

The Deadwood formation is composed essentially
of varicolored, frequently glauconitic sandstones,
micaceous shales of various colors, and minor car-
bonate rocks. The Winnipeg formation in Saskatch-
ewan may be divided into 2 units, a lower unit of
white quartzose sandstones and an upper unit consist-
ing predominantly of green shales interbedded with
argillaceous sandstones. Glauconitic sandstones
and micaceous shales of "Deadwood type" are pres-
ent in the lower part of the Winnipeg formation in
the W.-central part of the area.

The age of the Deadwood formation in Saskatch-
ewan is considered to be Upper Cambrian to Lower
Ordovician, and a Middle to Upper Ordovician age
for the Winnipeg formation is generally accepted,
although fossil evidence to support these conclusions
is lacking.

The rock types, high porosities, and the prolific
recoveries of salt water from both these formations,
strengthen the possibilities for future sources of

petroleum and natural gas, especially in the south-eastern part of the area, and possibly the W.-central part of the area.--Auth.

2-3274. Harris, Leonard D. DROWNED VALLEY TOPOGRAPHY AT BEGINNING OF MIDDLE ORDOVICIAN DEPOSITION IN SOUTHWEST VIRGINIA AND NORTHERN TENNESSEE (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B186-B189, illus., map, profiles, 1960) 4 refs.

Lower Ordovician rocks in SW. Virginia and northern Tennessee were 1) slightly uplifted to form a low coastal plain, 2) eroded to a gently rolling topography of moderate relief, and 3) inundated to form a submerged coastline with many drowned valleys. Deposition of reworked residuum and limestone of Middle Ordovician age followed.--Auth.

2-3275. Kent, D.M. THE EVAPORITES OF THE UPPER ORDOVICIAN STRATA IN THE NORTHERN PART OF THE WILLISTON BASIN: Saskatchewan, Dept. Mineral Resources, Rept. no. 46, 46 p., 11 figs. (3 in pocket), 5 pls. (photomicrographs), 2 tables, 1960, 48 refs.

As a result of epeirogenic movements of the basin and surrounding metastable shelf areas, the Upper Ordovician sediments of the northern part of the Williston basin are composed of 4 depositional cycles, each of which contains an evaporitic sequence. Each cycle consists of 5 phases, each phase being represented by a specific lithology: 1) fossiliferous fragmental limestone; 2) argillaceous dolomite; 3) anhydrite; 2) argillaceous dolomite; 1) fossiliferous fragmental limestone. The evaporites are considered to be primary and were laid down as intra-basin deposits due to a restriction of circulation in the northern part of the Williston basin. A shoal region towards the open sea formed a physical barrier to circulation; a dynamic barrier, developed between the denser saline brine in the evaporating basin and the less dense, nearshore waters, provided restriction on the landward side.

The evaporitic basin reached its maximum areal extent when the "A" evaporite of the Herald member was laid down. After that time, the limits of the evaporite basins did not extend much beyond the International Boundary area of Saskatchewan and North Dakota.

Stratigraphic traps, consisting of a porous facies overlain by an impervious layer such as the evaporite deposits, probably form the best reservoirs for the accumulation of hydrocarbons. Where the evaporites overlie radial domes or pitching anticlines, and the facies is favorable, oil may be accumulated. Oil accumulations may be present along tectonic hinge lines, to which the absence of Middle Devonian Prairie evaporites is thought also to be indirectly related.--Auth.

2-3276. Kaplun, L.I., and T.B. Rukavishnikova. THE SILURO-DEVONIAN BOUNDARY IN THE NORTH-EASTERN BALKHASH REGION: Akad. Nauk SSSR, Izvestiya, Geol. Ser., in translation, 1958, no. 11, p. 46-59, 3 figs., 3 pls., 3 tables, pub. June 1960, 5 refs.

The paper presents new data on the stratigraphy of the Upper Silurian and Lower Devonian deposits of the northeastern Balkhash region. The study of sections and faunas of these deposits shows that up-

per Ludlovian, Gedinnian, and Coblenzian faunal assemblages are present and that the Upper Silurian strata of the region pass without interruption into the lithologically similar Lower Devonian beds.--Auth.

2-3277. Lane, D.M. DAWSON BAY FORMATIONS IN THE QUILL LAKES-QU'APPELLE AREA, SASKATCHEWAN: Saskatchewan, Dept. Mineral Resources, Rept. no. 38, 49 p., 11 figs., 4 pls. (in pocket), 3 tables, 1960, 14 refs.

The Dawson Bay formation in the Quill Lakes-Qu'Appelle area of Saskatchewan is the second of 3 Middle Devonian evaporite cycles. Within the cycle these lithologies range from red shales through carbonates to halite. The formation is divided into 6 members comprising 7 phases of the cycle, the first 2 phases being grouped together into 1 member. These members are correlated by the combined use of mechanical logs and core data.

Lithologies and fossil assemblages provide lithologic and environmental evidence of the progress of the marine transgression and the subsequent uplift and restriction of the area of deposition. A halite bed, up to 65 ft. in thickness, occurs in a "barred basin" and marks the end of the deposition of the Dawson Bay formation in this area. Secondary halite has infilled much of the pore spaces within the Dawson Bay formation in the basin areas. The present porosities in the Dawson Bay formation are confined to areas outside that where the Hubbard evaporite is preserved and are indirectly controlled by the thickness of the underlying Prairie evaporite.--Auth.

2-3278. Brosge, William P. METASEDIMENTARY ROCKS IN THE SOUTH-CENTRAL BROOKS RANGE, ALASKA (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B351-B352, map, 1960) 2 refs.

In the S.-central Brooks Range, Devonian black slates and phyllites rest conformably(?) on Skagit limestone and unconformably on Middle(?) Devonian and older metasedimentary rocks. Metamorphic grade increases southward from slate to muscovite schist, then decreases to phyllite near the front of the range. Granite intrudes the schist, and most metal prospects are in the schist belt.--Auth.

2-3279. Sutton, Robert G. STRATIGRAPHY OF THE NAPLES GROUP (LATE DEVONIAN) IN WESTERN NEW YORK: New York State Mus. & Sci. Service, Bull. no. 380, 56 p., 11 illus., map (in pocket), chart, 2 secs. (in pocket), table, Apr. 1960, 43 refs.

The Upper Devonian Naples group in New York State is composed of 4 formations: Middlesex black shale (bottom), Cashaqua formation, Rhinestreet black shale, and Hatch formation (top). The Cashaqua formation is subdivided into 3 members: Sawmill Creek (new), Rock Stream, and Rye Point (new). These are recognized from Conesus Lake to Seneca Lake. The 4 formations may be traced from Lake Erie eastward to Seneca Lake where they intertongue with the Ithaca and Enfield formations of the Cayuga Lake region.

There is much evidence to support the conclusion that black muds (Middlesex and Rhinestreet) were deposited in the W. during the advance of the silty facies from the E. Gray muds with a restricted pelecypod and ammonoid fauna were present in the W. during the retreat of the silty facies. Variations in depth and circulation of the water appear to be the

principal factors governing the amount of organic matter in the muds.

Fine-grained, even-bedded siltstones and shales pass eastward into crossbedded siltstones and fine-grained sandstones. The thin siltstone beds of the Hatch formation and the Rock Stream member were deposited by turbidity currents.--Auth.

2-3280. Kents, Paul. **THREE FORKS AND BAKKEN STRATIGRAPHY IN WEST CENTRAL SASKATCHEWAN**: Saskatchewan, Dept. Mineral Resources, Rept. no. 37, 39 p., 8 figs., pl. (in pocket), 1960, 14 refs.

The Three Forks and Bakken sequence in W.-central Saskatchewan was laid down during a relatively brief period of mild uplift in late Devonian and early Mississippian times, preceding the beginning of the main stage in the development of the Williston basin. This sequence, though only about 300 ft. in thickness, contains a wide variety of different rock types, dolomites, anhydritic dolomites, red beds, green shales, black radioactive shales, sandstones and clastic biostromal limestone, which make it easily recognized in well cuttings and readily correlated from well to well.

In the northwestern part of the area the pre-Mesozoic strata were folded in post-Mississippian times, truncated and then buried by Mesozoic sediments. Data assembled from nearly all exploration wells in the area have revealed the presence of 6 anticlinal structures, 2 of which appear to be closed and of substantial length. These structures lie in a region adjacent to producing oil fields and therefore offer good petroleum possibilities. There are indications that more hidden structures may exist in which the pre-Mesozoic strata have been folded, thus adding to further oil and gas possibilities in the area.--Auth.

2-3281. Ross, Clyde P. **DIVERSE INTERFINGERING CARBONIFEROUS STRATA IN THE MACKAY QUADRANGLE, IDAHO** (In: U. S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B232-B233, 1960) 7 refs.

In the southeastern part of central Idaho the stratigraphy of the Paleozoic rocks varies within short distances, especially in the upper part of the sequence. Near Mackay, 3 formations that include representatives of most of Carboniferous time merge into a single map unit in which clastic rocks predominate.--Auth.

2-3282. McCabe, Hugh R. **MISSISSIPPIAN STRATIGRAPHY OF MANITOBA**: Manitoba, Dept. Mines & Nat. Resources, Mines Branch, Pub. 58-1, 99 p., 27 figs. (16 in pocket) incl. maps, secs., graphs, 1959, 64 refs.

The purpose of the report is to establish regional correlations of Mississippian strata in Manitoba and to show the regional patterns of sedimentation and their relation to the over-all Williston Basin Mississippian sequence. The study is fairly detailed, and is based on sample and mechanical log examination of more than 200 wells. General descriptions of all Mississippian strata are presented, as well as 17 selected core descriptions.

The lower Mississippian Lodgepole formation is subdivided into 2 operational marker-defined units which show marked differences in both structural evolution and lithofacies pattern, especially shale content. These variations may be due in part to salt

collapse phenomena related to the underlying Devonian Prairie evaporites. The upper Mississippian Mission Canyon and Charles strata show the characteristic cyclical interbedding of limestone and anhydrite, and shelfward facies change from limestone to evaporite.

Relationship of the oil occurrences in Manitoba to nearby occurrences in Saskatchewan and North Dakota is shown. In Manitoba, oil occurs primarily in stratigraphic truncation traps, with localization of accumulation apparently due to the northward structural rise of the Lodgepole subcrop belt and the presence of local structural and/or palaeotopographic features. Possibilities of additional oil occurrences are considered.

The relationship between calcite and anhydrite in the evaporation sequence is discussed. The 2 appear to be mutually exclusive, which would account for the extensive replacement of Mississippian limestones by anhydrite and dolomite.--Auth.

2-3283. McKee, Edwin D. **LITHOLOGIC SUBDIVISIONS OF THE REDWALL LIMESTONE IN NORTHERN ARIZONA - THEIR PALEOGEOGRAPHIC AND ECONOMIC SIGNIFICANCE** (In: U. S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B243-B245, 3 maps, 1960)

Recognition of 4 members within the Redwall limestone of northern Arizona has made possible the delineation of Early Mississippian paleogeographic elements in that area and has assisted in the exploration for petroleum by indicating regional stratigraphic trends and by furnishing readily recognizable horizon markers in the subsurface.--Auth.

2-3284. Campbell, Russell H. **GENERALIZED STRATIGRAPHIC SECTION OF THE LISBURNE GROUP IN THE POINT HOPE A-2 QUADRANGLE, NORTHWESTERN ALASKA** (In: U. S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B337-B339, 1960)

A stratigraphic section of the Lisburne group [Early and Late Mississippian], more than 5,700 ft. in total thickness and consisting chiefly of limestone, was measured during the summer of 1959 along continuous sea-cliff exposures SW. of Point Hope, Alaska. Five distinct lithologic units were recognized, which have been tentatively designated, in order of decreasing age, M₁, M₂, M₃, M₄, and M₅.--Auth.

2-3285. Sando, William J. **DISTRIBUTION OF CORALS IN THE MADISON GROUP AND CORRELATIVE STRATA IN MONTANA, WESTERN WYOMING, AND NORTHEASTERN UTAH** (In: U. S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B225-B227, map, 2 secs., 1960)

Corals collected from the Mississippian Madison group, Brazer dolomite, and Hannan limestone have led to the recognition of 5 faunal zones. These zones indicate that the Brazer, Mission Canyon, and Charles formations are in part equivalent to one another, and they are also helpful in correlating the Lodgepole and Hannan limestones.--Auth.

2-3286. Myers, Donald A. **STRATIGRAPHIC DISTRIBUTION OF SOME PENNSYLVANIAN FUSULINIDAE FROM BROWN AND COLEMAN COUNTIES, TEXAS**: U.S. Geol. Survey, Prof. Paper 315-C, p.

37-53, 10 pls., map, sec., table, 1960, 23 refs.

The stratigraphic succession of Pennsylvanian rocks that crop out in Brown and Coleman counties contains oil and gas in the subsurface in central Texas and is equivalent to rocks that contain large reservoirs of petroleum in western Texas.

The Pennsylvanian rocks that crop out in Brown and Coleman counties include the upper part of the zone of *Fusulina*, represented in the Strawn group undifferentiated, and the zone of *Triticites*, represented in the rocks of the Canyon and Cisco groups. The zone of *Triticites* extends upward into the Wichita group of Permian age. The fusulinid faunas are abundant and varied. Within the zone of *Triticites* each limestone bed or group of limestone beds contains a distinctive assemblage of fusulinids. The genus *Triticites* exhibits a general evolutionary series embracing the small thin-walled and relatively simple species in the lower part of the Canyon group, and the large ventricose thick-walled species in the upper part of the Cisco group. The gradation between species is believed to proceed at a more or less uniform rate, and by comparing evolutionary stages it is possible to make correlations of the containing rock units.--Auth.

2-3287. Bachman, George O. SOUTHWESTERN EDGE OF LATE PALEOZOIC LANDMASS IN NEW MEXICO (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B239-B241, map, sec., 1960) 9 refs.

About 12 mi. E. of Tularosa, the Abo formation of Permian age overlies Precambrian rocks. This relation represents an overlap during Permian time of about 5,500 ft. of Paleozoic strata and helps establish the southwestern margin of the late Paleozoic Pedernal landmass.--Auth.

2-3288. Pelletier, B.R. TRIASSIC STRATIGRAPHY, ROCKY MOUNTAIN FOOTHILLS, NORTHEASTERN BRITISH COLUMBIA: Canada, Geol. Survey, Paper 60-2, 32 p., map, sec., 1960, 13 refs.

Triassic rocks are assigned to the Grayling, Toad, and Liard formations characterized respectively by *Claraia stachei*; *Wasatchites-Beyrichetes-Gymnotoceras*; and *Nathorstites*. Triassic disconformably overlies late Paleozoic bedded chert and, in turn, is overlain disconformably by dark gray shales of Lower Cretaceous age. Primary current-structures in the Triassic indicate an E. and NE. source for the sediments, which become progressively coarser from bottom to top of the section, passing respectively from deeper offshore shales and siltstones to shallow marine sandstones. Ancient shorelines trended northwesterly, according to direction of wave ripple marks, and appear to have migrated southwestward. Sandstone units consist, in many cases, of offshore bars which presumably lay parallel to shorelines and thus trend northwesterly. Such bodies have been reported as gas-producers in subsurface formations E. of the foothills; therefore, extended exploration of proven fields along northwesterly trends may be profitable.--P. Harker.

2-3289. Thayer, T.P., and C.E. Brown. UPPER TRIASSIC GRAYWACKES AND ASSOCIATED ROCKS IN THE ALDRICH MOUNTAINS, OREGON (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B300-B302, map, 1960) ref.

The Aldrich Mountains consist mainly of Upper Triassic volcanic graywackes and shales, andesitic tuffs, basaltic lavas, conglomerates, and breccias 40,000 to 50,000 ft. in aggregate thickness. Turbidites, slide breccias, and fragments of Upper Triassic rocks in conglomerates, together with angular unconformities and abrupt or rapid sedimentary thickening caused by contemporaneous subsidence, show that deposition was accompanied by strong deformation and reworking of rocks along basin borders.--Auth.

2-3290. Tuchkov, I.I. KARNIC DEPOSITS OF NORTHEASTERN U.S.S.R., AND THEIR LOWER BOUNDARY: Akad. Nauk SSSR, Izvestiya, Geol. Ser., in translation, 1958, no. 10, p. 74-84, map, pub. June 1960, 17 refs.

English translation of GeoScience Abstracts 1-659

2-3291. Moore, James G. MESOZOIC AGE OF ROOF PENDANTS IN WEST-CENTRAL NEVADA (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B285-B288, map, table, 1960) 5 refs.

Fossils have been collected from prebatholithic, partly metamorphosed rocks, dominantly of volcanic origin, at 13 localities in Lyon, Douglas, and Orms counties, western Nevada. These fossils indicate that all the pre-batholithic rocks, are of Late Triassic and Early Jurassic age.--Auth.

2-3292. Oliver, Thomas A. THE VIKING - CADOTTE RELATIONSHIP: Alberta Soc. Petroleum Geologists, Jour., v. 8, no. 9, p. 247-253, map, chart, 4 secs., log, Sept. 1960, 5 refs.; also published: Edmonton Geol. Soc., Quart., v. 4, no. 1, p. 1-3, 6-8, March 1960.

The relationship between the Lower Cretaceous Viking and Peace River sands in W.-central Alberta has been debated for some time. Four subsurface cross-sections across the critical area show an interpretation which agrees with an interpretation by Stelck based on fossil evidence. Based on electric log correlations and sample and core examination, an unconformity is shown truncating the Cadotte sand and the underlying Harmon shale. The Viking formation is considered to be partially equivalent to the Paddy, and the Joli Fou shale is considered to be wedging out by onlap onto truncated Cadotte. If acceptable, the correlations presented allow much more precise nomenclature areas to be set up for these rock units.--Auth.

2-3293. Edwards, R.G. CRETACEOUS SPINNEY HILL SAND IN WEST-CENTRAL SASKATCHEWAN: Alberta Soc. Petroleum Geologists, Jour., v. 8, no. 5, p. 141-153, 3 illus., 5 maps, 3 secs., diag., 2 tables, May 1960, 8 refs.

The Lower Cretaceous Spinney Hill member is a sandstone facies developed within the lower beds of the Joli Fou formation of W.-central Saskatchewan. The member is composed of interbedded marine shales and fine-grained, well-sorted glauconitic sandstones and has a maximum thickness of 110 ft. It has a tongue-like area of deposition and represents the offshore marine phase of deltaic and tidal flat sedimentation. The source of the Spinney Hill sand was the Precambrian shield N. and E. of the area that the sand now occupies.--Auth.

2-3254. Applin, Paul L. SIGNIFICANCE OF CHANGES IN THICKNESS AND LITHOFACIES OF THE SUNNILAND LIMESTONE, COLLIER COUNTY, FLA. (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B209-B211, map, sec., 1960) 2 refs.

During the middle part of Lower Cretaceous Trinity (Comanche) time, the site of the Sunniland oil field in Collier County, Florida, bordered a starved basin. The oil-bearing Sunniland limestone is about 250 ft. thick in the field, but 25 mi. SW. it is 69 ft. thick and composed of dark S-bearing shale and interbedded thin lenses of dark argillaceous limestone.--Auth.

2-3295. Grantz, Arthur, and David L. Jones. STRATIGRAPHY AND AGE OF THE MATANUSKA FORMATION, SOUTH-CENTRAL ALASKA (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B347-B350, map, secs., table, 1960) 3 refs.

The Matanuska formation, of late Early and Late Cretaceous age, consists of several lithogenetic units deposited in an unstable seaway from sources both to the N. and to the S. The part of the formation that underlies Cook Inlet and the Copper River lowlands might prove to be a source of petroleum.--Auth.

2-3296. Brown, Robert D., Jr., and Ernest I. Rich. EARLY CRETACEOUS FOSSILS IN SUBMARINE SLUMP DEPOSITS OF LATE CRETACEOUS AGE, NORTHERN SACRAMENTO VALLEY, CALIFORNIA (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B318-B320, map, sec., 1960) 2 refs.

Early Cretaceous fossils from immediately beneath the Upper Cretaceous Venado formation are associated with pebbly mudstone and with exotic blocks of plutonic and sedimentary rock. This association is interpreted as the result of submarine landsliding and accounts for the presence of Early Cretaceous fossils in a thick sequence of Upper Cretaceous rocks.--Auth.

2-3297. Zapp, Alfred D., and W.A. Cobban. SOME LATE CRETACEOUS STRAND LINES IN NORTHWESTERN COLORADO AND NORTHEASTERN UTAH (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B246-B249, 2 maps, 3 secs., 1960) 15 refs.

Eastward withdrawal of the interior sea during the late Campanian and Maestrichtian epochs was interrupted by at least 5 major readvances of the sea for distances ranging from 8 to 75 mi., as recorded by tongues of marine strata penetrating nonmarine strata. Strand lines, as inferred from outcrop studies, show a generally progressive counter-clockwise rotation from northeasterly (oldest) to northwesterly (youngest).--Auth.

2-3298. Dane, Carle H. NEW INFORMATION ON THE AREAL EXTENT OF SOME UPPER CRETACEOUS UNITS IN NORTHWESTERN NEW MEXICO (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B241-B243, 6 maps, 1960) 8 refs.

The Tres Hermanos sandstone member of the

Mancos shale, the so-called "stray" sandstone of the Mesaverde group, and the Dalton sandstone member of the Crevasse Canyon formation have greater extent than previously recognized. All wedge out northeastward into marine shale in the northern part of the San Juan basin.--Auth.

2-3299. Williams, John R. CENOZOIC SEDIMENTS BENEATH THE CENTRAL YUKON FLATS, ALASKA (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B329, 1960) 3 refs.

The 1954 U.S. Army Corps of Engineers water well at Fort Yukon encountered 48 ft. of eolian sand, 100 ft. of Pleistocene alluvial gravel, and 292 ft. of silt and silty sand interpreted as quiet-water (lake?) sediments of late Tertiary or early Quaternary age. Permafrost was logged from 8 to 320 ft.--Auth.

2-3300. Zaklinskaya, E.D. PRINCIPLES OF PALEOFLOREAL DIFFERENTIATION OF CENOZOIC DEPOSITS IN THE KAZAKHSTAN AND ADJOINING PARTS OF THE WEST SIBERIAN PLAIN: Akad. Nauk SSSR, Izvestiya, Geol. Ser., in translation, 1958, no. 10, p. 56-73, 5 figs. incl. maps, pub. June 1960, 29 refs.

English translation of GeoScience Abstracts 1-661.

2-3301. Hail, William J., Jr., and Estella B. Leopold. PALEOCENE AND EOCENE AGE OF THE COALMONT FORMATION, NORTH PARK, COLORADO (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B260-B261, 1960) 2 refs.

Identification of Eocene pollen assemblages including Platyacarya, Tilia, and Gramineae, from beds in the upper part of the Coalmont formation, together with previously identified Paleocene fossil leaves from underlying beds, demonstrates a Paleocene-Eocene age for the Coalmont formation.--Auth.

2-3302. Applin, Esther R. A TROPICAL SEA IN CENTRAL GEORGIA IN LATE OLIGOCENE TIME (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B207-B209, map, log, 1960) 8 refs.

The Miogypsina and Eulepidina zones and other less critical faunal units have recently been found to occur through 600 ft. of a well section in Georgia. The zonal sequence there is similar to that previously worked out in Puerto Rico and the Panama Canal region. The presence also of *Helicolepidina paucispira* in the section indicates a very young phase of the Ocala limestone close to the upper Eocene of Trinidad. These discoveries prove for the first time that this part of Georgia was invaded by the sea in Oligocene time.--Auth.

2-3303. Robinson, G.D. MIDDLE TERTIARY UNCONFORMITY IN SOUTHWESTERN MONTANA (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B227-B228, map, 1960) 5 refs.

This unconformity, long suspected, has been mapped in Townsend, Clarkston, and Three Forks basins. Simple lithologic guides make it possible to distinguish broadly similar rocks above and below the unconformity. Vertebrate fossils give evidence

that confirms the mapping and that dates the rocks. The unconformity is the result of deep erosion and probably some deformation in late Oligocene to middle Miocene time.--Auth.

2-3304. Fisher, Richard V., and Ray E. Wilcox. **THE JOHN DAY FORMATION IN THE MONUMENT QUADRANGLE, OREGON** (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B302-B304, table, 1960) 2 refs.

A major part of this formation [late Oligocene and early Miocene], appears to consist of volcanic ash retransported by wind and a minor part of ash that fell directly to its present position. The lower part of the formation contains a good deal of material carried by wind from saprolite, in part reworked, developed on the Clarno formation [Eocene].--Auth.

2-3305. Tschanz, Charles M. **REGIONAL SIGNIFICANCE OF SOME LACUSTRINE LIMESTONES IN LINCOLN COUNTY, NEVADA, RECENTLY DATED AS MIOCENE** (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B293-B295, map, 1960) 4 refs.

Widely distributed lacustrine limestone in Lincoln County, dated as Miocene by recently studied pollen, correlates with limestone exposed elsewhere in southeastern Nevada and southwestern Utah, including the Horse Spring formation, which a recent K-A determination shows to be Miocene rather than Eocene as formerly supposed.--Auth.

2-3306. Walker, George W. **AGE AND CORRELATION OF SOME UNNAMED VOLCANIC ROCKS IN SOUTH-CENTRAL OREGON** (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B298-B300, map, 1960) 6 refs.

A sequence of volcanic rocks extensively exposed in southeastern Lake County has yielded vertebrate fossils of Miocene age comparable in part to faunas occurring in volcanic rocks of central Oregon and adjacent parts of Nevada. The general stratigraphic relations of the Lake County rocks are similar to those of the central Oregon deposits, but apparently differ in detail from those of volcanic rocks of comparable age in Nevada and northeastern California.--Auth.

2-3307. Hansen, Wallace R., Douglas M. Kinney, and John M. Good. **DISTRIBUTION AND PHYSIOGRAPHIC SIGNIFICANCE OF THE BROWNS PARK FORMATION, FLAMING GORGE AND RED CANYON AREAS, UTAH-COLORADO** (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B257-B259, map, 1960) 6 refs.

Remnants of the Browns Park formation (Miocene?) in the Flaming Gorge and Red Canyon areas lie well below the Bear Mountain erosion surface. Their topographic setting indicates that deep canyons were cut in this surface before the Browns Park formation was deposited.--Auth.

2-3308. Salnikov, B.A. **STRATIGRAPHY OF THE VERKHNE-DUYSK SUITE OF THE WESTERN COAST OF SAKHALIN**: Akad. Nauk SSSR, Izvestiya, Geol. Ser., in translation, 1958, no. 12, p. 14-23, map, 2 secs., pub. July 1960, 12 refs.

A cyclic facies analysis of sections of the [middle

Miocene] Verkhneduysk formation along the western coast of Sakhalin makes it possible to subdivide it into 5 mesocycles (A, B1, B2, C1, C2) corresponding to the 5 stages of middle Miocene coal accumulation: essentially continental, continental-lagunal, lagunal, lagunal-marine, and essentially marine.

Depending on the character of the periodic movements, different sections of the formation contain a different number of sedimentary cycles. However, the comprehensiveness of major movements makes it possible to correlate even distant sections by their mesocycles which are represented in the section (especially in the upper part of the section).

Correlation by mesocycles is corroborated by a number of key horizons which maintain their lithologic and faunal characteristics throughout wide areas.

The lower formation boundary should be drawn on the coarsest stratigraphic unit at the base of mesocycle A, and common to all sections.

In most instances, the upper formation boundary cannot be determined with certainty. It should be drawn arbitrarily on the upper boundary of the upper cycle which carries continental deposits, i.e., on mesocycle C2.--Auth.

2-3309. Hail, William J., Jr., and G. Edward Lewis. **PROBABLE LATE MIOCENE AGE OF THE NORTH PARK FORMATION IN THE NORTH PARK AREA, COLORADO** (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B259-B260, 1960) 6 refs.

Fossils of *Merychippus* and *Brachycrus* from the type area of the North Park formation, Colorado, and from the North Park formation farther N. in Colorado and southern Wyoming, suggest that the formation is late Miocene in age.--Auth.

2-3310. Van Alstine, Ralph E., and G. Edward Lewis. **PLIOCENE SEDIMENTS NEAR SALIDA, CHAFFEE COUNTY, COLORADO** (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B245, 1960) 2 refs.

Clays, silts, sands, and gravels near Salida are dated as of probable early Pliocene age from horse teeth and camel bones. The sediments rest unconformably on Precambrian igneous and metamorphic rocks and Tertiary volcanics and are overlain by glacial outwash.--Auth.

2-3311. Hopkins, David M., and F. Stearns MacNeil. **A MARINE FAUNA PROBABLY OF LATE PLIOCENE AGE NEAR KIVALINA, ALASKA** (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B339-B342, map, sec., table, 1960) 10 refs.

A newly discovered molluscan and microfossil fauna near Kivalina, Alaska, provides evidence that Bering Strait was in existence as a seaway connecting the Pacific and Arctic oceans during late Pliocene time.--Auth.

2-3312. Hamilton, Warren B. **PLIOCENE(?) SEDIMENTS OF SALT WATER ORIGIN NEAR BLYTHE, SOUTHEASTERN CALIFORNIA** (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B276-B277, 1960)

Sediments of Pliocene, or possibly early Pleistocene, age, carrying an abundant fauna of both marine and brackish-water types, occur in the southeastern

PALEONTOLOGY

Big Maria Mountains, W. of the Colorado River and 75 mi. N. of the Mexican border. Either a huge saline lake existed here, perhaps dammed 50 mi. to the S., or else the Gulf of California extended into the area.--Auth.

2-3313. Radforth, Norman W., and Jaan Terasmae. A PALYNOLOGICAL STUDY RELATING TO THE PLEISTOCENE TORONTO FORMATION: *Can. Jour. Botany*, v. 38, no. 4, p. 571-580, table, July 1960, 17 refs.

The present palynological study is used as a new approach to determine the stratigraphical and chronological position of the Pleistocene interglacial deposits, the Toronto formation, exposed in sections at Toronto, Ontario, Canada.

An interpretation of lithology, combined with evidence supplied by the pollen and spore assemblages, indicates that the Don beds, the lower member of the Toronto formation, belong to the Sangamon Interglacial. The Scarborough beds, the upper member of the formation, were deposited during a non-glacial interval, cooler than the present. Conformity between the 2 members is questioned on grounds of lithological and palynological evidence.

Results of palynological studies, as indicated by this investigation, can be used for interpretation of the mode of deposition of certain laminated sediments and for reconstruction of past types of landscape.--Auth.

2-3314. Richmond, Gerald M., and Warren B. Hamilton. THE LATE QUATERNARY AGE OF OBSIDIAN-RHYOLITE FLOWS IN THE WESTERN PART OF YELLOWSTONE NATIONAL PARK, WYOMING (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B224-B225, map, 1960)

Obsidian-rhyolite flows of the Madison plateau

overlap moraines of the Bull Lake glaciation and are overlapped by moraines of the Pinedale glaciation.--Auth.

2-3315. Coulter, Henry W., Keith M. Hussey, and John Blandford O'Sullivan. RADIOCARBON DATES RELATING TO THE GUBIK FORMATION, NORTHERN ALASKA (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B350-B351, 1960) ref.

Radiocarbon dates indicate that deposition of the upper member of the Gubik formation was initiated prior to 38,000 years B.P. and was terminated prior to 9,100 years B.P.--Auth.

2-3316. Stern, Thomas W., and others. LEAD-ISOTOPE AGE STUDIES IN CARBON COUNTY, PENNSYLVANIA (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B45-B48, 2 diags., 2 tables, 1960) 8 refs.

U-bearing samples from Mount Pisgah (Mauch Chunk formation of Mississippian age) and Penn Haven Junction (Catskill formation of Devonian age) give discordant Pb-U ages ranging from 240 to 440 million years. Detailed evaluation of these discordant ages suggests that the U at both occurrences was elapsed during Late Jurassic or Early Cretaceous time.--Auth.

2-3317. Foster, Helen L. THE STRATIGRAPHY OF ISHIGAKI-SHIMA, RYÜKYÜ-RETTÖ (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B372, 1960)

Ishigaki-shima consists of Paleozoic (?) metamorphic rocks and Mesozoic or Tertiary intrusives overlain unconformably by upper Eocene sedimentary rocks, Tertiary volcanic rocks, and Pleistocene clay, gravel, and reef limestone.--Auth.

5. PALEONTOLOGY

See also: Areal and Regional Geology 2-3181, 2-3182; Stratigraphy 2-3285, 2-3286, 2-3290, 2-3300, 2-3311, 2-3313.

2-3318. Wheeler, Walter H. THE UNTATHERES AND THE COPE-MARSH WAR: *Science*, v. 131, no. 3408, p. 1171-1176, 2 illus., 2 ports., Apr. 22, 1960, 6 refs.

The untathere, a large extinct mammal found in the Eocene formations of the American Southwest became the center of a bitter controversy between 2 vertebrate paleontologists during the 1870's. Both Edward Drinker Cope and Othniel Charles Marsh published papers on these mammals during the summer of 1872, and each attempted to prove the other was wrong in his representations and in error in his interpretations. The rivalry grew personal, bitter, and culminated in stolen materials and plagiarized papers. By 1889 the government stepped in and demanded the specimens Cope had collected for the National Museum collection. Cope was indignant and found that William Ballou of the New York Herald would air his side of the issue publicly, as he did in 9 columns of his newspaper. This was followed by newspaper interviews with members of Marsh's expeditions and other men in the field not directly involved in the feud. All this bickering also led to

a confusion in nomenclature which took some time to clear up, and not before further name calling was carried on. Despite all this feuding, Cope, Marsh, and Leidy stand as the founders of vertebrate paleontology.--B.C. Schreiber.

2-3319. Fox, Sidney W. HOW DID LIFE BEGIN? *Science*, v. 132, no. 3421, p. 200-208, illus., 5 diags., 3 tables, July 22, 1960, approx. 50 refs.

In a letter written in 1871, Darwin theorized on the conditions needed for life to be generated. It is amazing that he foresaw the very things that are today considered the probable origins of life. This beginning has been augmented by much research on proteins, virus, amino acids, and thermal control of interaction and progression from the simpler of these to the more complex. The relation of these changes to the theorized conditions under which life first began has also been considered, and a postulated cycle of conditions which may lead to generation of life is described.--B.C. Schreiber.

2-3320. Henbest, Lloyd G. FOSSIL SPOOR AND THEIR ENVIRONMENTAL SIGNIFICANCE IN MORROW AND ATOKA SERIES, PENNSYLVANIAN,

WASHINGTON COUNTY, ARKANSAS (In: U. S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B383-B385, 8 illus., 1960) 7 refs.

Abundant spoor of unknown animals characterize members of the Morrow and Atoka series that were deposited in aerated estuarine(?) and shallow marine waters, disproving that similar spoor are exclusive indicators of abyssal origin of flysch sediments. These spoor are valuable indicators of facies and of original attitude of folded rocks.--Auth.

2-3321. Oliver, William A., Jr. DEVONIAN RUGOSE CORALS FROM NORTHERN MAINE: U.S. Geol. Survey, Bull. 1111-A, 23 p., 49 illus. on 5 pls., 2 diags., 2 tables, 1960, 43 refs.

Corals which were collected by A.J. Boucot from rocks of Devonian age in the Moose River synclorium, northern Maine, are from the Beck Pond limestone of Helderberg age and the upper part of the Moose River sandstone of Schoharie age.

Four new rugose coral species from 2 Beck Pond limestone faunules are assigned to the genera *Amploxiphyllum*, *Briantelasma*, *Lyrielasma*, and *Tryplasma*. Some fragmentary *Favosites* are also described. Specimens are fairly abundant and well preserved. Species that are morphologically similar are known from the Helderberg group in New York and the Keyser limestone in Maryland and adjacent states. One of the Beck Pond faunules represents a biostrome environment. The other may have been collected from an off-biostrome facies or may be from rocks of slightly different age.

Corals were an important part of the upper Moose River fauna; but preservation is poor, and the material is inadequate for formal taxonomic treatment.--Auth.

2-3322. Oliver, William A., Jr. CORAL FAUNAS IN THE ONONDAGA LIMESTONE OF NEW YORK (In: U. S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B172-B174, chart, 1960) 8 refs.

Rugose corals from the lowest 2 ft. of the Onondaga limestone [Middle Devonian] in western New York differ markedly from previously described New York Onondaga corals. They appear to be of the same age as coral assemblages in the lowest Jeffersonville limestone at the falls of the Ohio River, and in the Bois Blanc formation of Ontario. An upper coral assemblage, of Middle Devonian age, characterizes most of the Onondaga limestone and persists into the overlying Hamilton group. This assemblage also occurs above the lower assemblage in the other areas mentioned.--Auth.

2-3323. Boardman, Richard S. TREPOSTOMATOUS BRYOZOA OF THE HAMILTON GROUP OF NEW YORK STATE: U.S. Geol. Survey, Prof. Paper 340, 87 p., 22 pls., 2 maps, 4 charts, 7 secs., 11 diags., 3 graphs, 1960, 71 refs.

The trepostomatous Bryozoa known from the Middle Devonian Hamilton group of New York represent 26 species and 2 subspecies belonging to 10 genera and 1 subgenus. Two genera, *Polycylindricus* and *Loxophragma*; the subgenus, *Leptotrypella* (*Pycnobasis*); and 19 species and the 2 subspecies are new.

In the area of study from Lake Erie to Owasco Lake, Trepostomata are known only from the Ludlow-

ville and Moscow formations. Some species have a restricted stratigraphic distribution. In the Ludlowville shale 4 species are restricted to the Centerfield limestone member, 1 subspecies to the Ledyard member of Cooper, 3 species to the Wanakah member as used by Buehler and Tesmer, and 1 species is restricted to the King Ferry shale member of Cooper. In the Moscow shale, 1 species and 1 subspecies are restricted to the Kashong member of Cooper, and 4 species are restricted to the uppermost Windom member.

The Hamilton rocks of western and central New York consist largely of calcareous mudstone, shale, and limestone. Five rock types are represented, and these are closely correlated with the distribution of faunas. Trepostomata are abundant in the calcareous mudstone facies, sparse in the siltstone and coral-bearing limestone, and were not found in the dark shale and sandstone. Application of Stach's findings on Recent Bryozoa to the Hamilton species suggests that growth habit was controlled largely by the amount of agitation in the water, "unstable" species developing ramose colonies in quiet water and incrusting colonies in agitated water. The predominantly incrusting colonies and bioclastic matrix in the coral-bearing limestone facies suggest agitated waters; the predominantly ramose colonies preserved as complete zoaria in the calcareous mudstone facies suggest quieter waters.

The defined members of the Ludlowville and Moscow formations are considered, on the basis of the distribution of the bryozoan species, to be essentially coeval, and phylogenetic lineages are inferred in 3 genera. A general increase in size of zoaria is demonstrated in the lineages of the 3 genera.

The present study indicates that amalgamate and integrate wall structures in tangential sections are not reliable subordinal criteria, primarily because occurrence of amalgamate or integrate walls is not always constant within a species or genus. Longitudinal sections demonstrate that either an amalgamate or an integrate appearance can be produced by variations in either one of 2 wall structures now tentatively considered to be fundamentally different and taxonomically important. Hamilton genera do not fit into the present family classification, partly due to the lack of recognizable "primary" and "secondary" parts of zoecial walls. A tentative grouping of the Middle Devonian genera is based on the configuration of the laminae in the zoecial walls as seen in both longitudinal and tangential sections. One tentative subordinal group includes genera displaying stereo-toechid, leiocleimid, trachytoechid, and leptotrypellid wall structures, all defined in this paper. The other group includes the genera showing atactotoechid wall structure, also defined. The wall structure for each of the Hamilton genera is described in detail, and previously described species are reassigned where necessary.

The nearly complete ramose zoaria collected in the Hamilton group furnished material for study of morphologic variation within a colony. The amount of variation indicates that "species" could be and probably have been differentiated on characters commonly occurring in a single zoarium. Intra-zoarial variation of characters falls into 2 natural groups: that controlled by growth stages (ontogeny), and that largely independent of ontogeny. To evaluate and make usable characters affected by ontogeny, growth stages are arbitrarily defined by numbers of diaphragms in the zoecia. Measurements of the other ontogenetic characters, primarily width of Ephebic zone and axial ratio, are recorded for each

of these growth stages and presented either in scatter diagrams or tables. After study of complete trepostomatous zoaria of the Hamilton group, it is evident that if a reasonable number of disassociated fragments of trepostomes from the average collection is studied, an adequate approximation of growth stages can be obtained and more realistic species concepts established.

The nearly complete ramose zoaria also provide information on the nature of growth in branching colonies. A proposed growth hypothesis is based on cyclic growth and resorption. Thick zooecial walls were periodically formed around the ends of the branches, as shown by their presence in 80% of the sectioned growing tips. The thick zooecial walls were partly resorbed in the growing tip region, and active thin-walled growth followed, extending the neanic zones and branch lengths distally. The formation of new thick-walled zones around the tips completed the cycle. Proximal to the growing tips, the zooecia assumed permanent positions opening along the sides of the branches. Here growth was relatively constant with no sign of resorption, and progressively older growth stages occur toward the bases of zoaria.--Auth.

2-3324. Vedder, John G. PREVIOUSLY UNREPORTED PLIOCENE MOLLUSCA FROM THE SOUTHEASTERN LOS ANGELES BASIN (In: U.S. Geological Survey. Geological Survey Research 1960: Its Prof. Paper 400-B, p. B326-B328, 3 tables, 1960) 10 refs.

Molluscan faunas from 2 geographically separate stratigraphic units in the San Joaquin Hills-San Juan Capistrano area represent different depth facies of approximately the same age. The fossil assemblages are similar both in content of distinctive forms and in inferred bathymetric distribution to well-known faunas of late Pliocene age from Santa Maria, Los Angeles, and San Diego, California.--Auth.

2-3325. Ladd, Harry S. DISTRIBUTION OF MOLLUSCAN FAUNAS IN THE PACIFIC ISLANDS DURING THE CENOZOIC (In: U.S. Geological Survey. Geological Survey Research 1960: Its Prof. Paper 400-B, p. B374-B375, map, 1960) 4 refs.

Fossil collections from the Palau, Marianas, Marshall, Ellice, New Hebrides, and Fiji islands in the western Pacific suggest that faunas were more abundant and diversified during Tertiary times than they are today. Many elements of the "Indo-Pacific fauna," generally believed to have spread from Indonesia, may have originated in the islands.--Auth.

2-3326. Popov, Yu. N. FINDING OF OTOCERAS IN THE LOWER TRIASSIC OF THE EASTERN VERKHOKHAYAN REGION: Akad. Nauk SSSR, Izvestiya, Geol. Ser., in translation, 1958, no. 12, p. 86-89, 2 illus., pub. July 1960, 10 refs.

A description of ammonites belonging to the species *Otoceras* Griesbach in the Lower Triassic of the eastern Verkhoyansk region. Until now, this species was found only in the Himalayas and eastern Greenland. This finding links the Himalayan and Greenlandian zones of the expansion of *Otoceras* Griesbach together, showing the possible way of migration from the Pacific basin through the Verkhoyansk geosynclinal sea in the boreal zoogeographic zone. A detailed description of *Otoceras* Griesbach is given.--Auth.

2-3327. Imlay, Ralph W. AMMONITES OF EARLY CRETACEOUS AGE (VALANGINIAN AND HAUTERIVIAN) FROM THE PACIFIC COAST STATES: U.S. Geol. Survey, Prof. Paper 334-F, p. 167-228, 20 pls., 3 maps, chart (in pocket), 4 tables, 1960, 82 refs.

Study of the ammonites in the earliest Cretaceous of California, Oregon, and Washington has made possible the recognition of 4 ammonite zones in beds of Valanginian age and 5 ammonite zones in beds of Hauterivian age. These zones provide general correlations with the Valanginian and Hauterivian stages in other parts of the world and detailed correlations along the Pacific coast. These correlations are strengthened by the associations of the Valanginian ammonites with the Valanginian pelecypod *Buchia crassicolis* (Keyserling) and by the absence of earlier Cretaceous species of *Buchia* that occur from Washington northward to Alaska. On the basis of such associations, the oldest Cretaceous beds exposed in California and Oregon are considered to be not older than Valanginian and probably not older than middle Valanginian.

Failure to find in California certain ammonite zones of late Valanginian to early Hauterivian age that are present in southwestern Oregon may be explained by nondeposition, slow deposition, unfavorable facies, inadequate collections or some combination of these possibilities.

The Valanginian-Hauterivian ammonites found in the Pacific Coast states have a local aspect, owing to the presence of genera not yet found elsewhere, or only rarely elsewhere, and to the absence of genera that are common elsewhere. Provincial genera include *Wellsia*, *Hannaites*, *Hollisites*, and *Hertlenites*. Besides these genera, *Shasticioceras* has been found elsewhere only in British Columbia and Japan, and *Homolosomes* only in British Columbia and Greenland. The absence of such ammonites as *Rogersites*, *Valanginites*, *Distoloceras*, and *Leopoldia* is in contrast to their abundance in the Mediterranean province and Mexico. With these exceptions the Valanginian ammonites from the Pacific coast show affinities more strongly with ammonites in the Mediterranean province than with northern Eurasia, and the Hauterivian ammonites show affinities mostly with ammonites in northern Eurasia.--Auth.

2-3328. Imlay, Ralph W. EARLY CRETACEOUS (ALBIAN) AMMONITES FROM THE CHITINA VALLEY AND TALKEETNA MOUNTAINS, ALASKA: U.S. Geol. Survey, Prof. Paper 354-D, p. 87-114, 9 pls., 3 maps, chart, 3 tables, 1960, 55 refs.

The Early Cretaceous (Albian) ammonites of the Chitina Valley and Talkeetna Mountains, Alaska, belong to 4 faunules ranging in age from early to early middle Albian.

The lowest faunule in the Chitina Valley is characterized by *Leconteites modestus* (Anderson) and by species of *Puzosigella* that permit a close correlation with the *Leconteites lecontei* zone of California and Oregon and hence with the early Albian of Eurasia. *Moffittites crassus* Imlay, n. sp., also may be characteristic of this faunule.

The next higher faunule in the Chitina Valley is characterized by *Moffittites robustus* Imlay and *Leconteites deansii* (Whiteaves). It is probably only slightly younger than the *Leconteites lecontei* zone of California and Oregon. The next higher Albian faunule in the Chitina Valley is characterized by a coarsely ribbed variant of *Brewericeras breweri*

(Gabb) that suggests approximate correlation with the *Brewericeras hulenense* zone in California. An early Albian age for this faunule is indicated by the ammonites *Valdedorsella*, *Parasilesites*, and sub-genus *Subarcthoplites*.

In the Talkeetna Mountains the only Albian representative is the *Freboldiceras singulare* faunule, which is characterized by excellently preserved specimens of *Beudanticeras glabrum* (Whiteaves), *Freboldiceras singulare* Imlay, and *Lemuroceras talkeetanum* Imlay, n. sp. These are either identical with or closely related to ammonites in the western interior of Canada beneath beds that contain *Gastropylites*. The faunule is probably younger than the *Lemuroceras belli* zone of Canada and the *Brewericeras breweri* faunule of the Chitina Valley, but the evidence is not conclusive. If it is younger, its age is probably early middle Albian.

The Albian ammonite faunules of the Chitina Valley have a provincial aspect owing to the presence of genera not yet found outside the Pacific coast of North America. These include *Moffittites*, *Kenicotia*, *Brewericeras*, *Leconteites*, *Puzosigella*, *Hulenites*, and *Parasilesites*. A marine connection with the boreal province through Canada or Alaska is indicated, however, by the presence of such ammonites as *Lemuroceras* (*Subarcthoplites*) and *Callizoniceras*. In addition the faunules include many genera that are distributed nearly worldwide, or that do not characterize any particular province. The Albian ammonites of the Talkeetna Mountains likewise exhibit a provincial aspect, but in contrast to those from the Chitina Valley, the relationships are strong with the western interior of Canada and with northern Alaska.

These faunal relationships imply that the Albian sea that covered southern Alaska had broad connections with seas in the western interior of the continent, in California and Oregon, and in Asia.--Auth.

2-3329. Whitmore, Frank C., Jr. FOSSIL MAMMALS FROM ISHIGAKI-SHIMA, RYUKYU-RETTO (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B372-B374, 1960) ref.

Collection of fossil mammals from the island group connecting Taiwan and Japan helps interpret its geologic history. One suite, consisting mainly of extinct deer, probably indicates migrations from the S. over dry land. The other, composed of pig bones about 8,000 years old, may be an early example of domestication.--Auth.

2-3330. Henbest, Lloyd G. PALEONTOLOGIC SIGNIFICANCE OF SHELL COMPOSITION AND DIAGENESIS OF CERTAIN LATE PALEOZOIC SEDENTARY FORAMINIFERA (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B386-B387, 1960) 4 refs.

Petrologic study of *Serpulopsis*, typical genus of late Paleozoic *Tolypamminidae*, reveals criteria, including differences in extinction in grains of aggregate, applicable for demonstrating agglutinate origin of similar shells. Unusual preservations of *Apterinella* show diagenetic stages from original magnesian calcite shell to problematic and product that composes virtually all fossils of Paleozoic *Cornuspirinae*.--Auth.

2-3331. Smith, Patsy Beckstead. FOSSIL FORAMINIFERA FROM THE SOUTHEASTERN CALIFOR-

NIA DESERTS (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B278-B279, table, 1960) 4 refs.

A few species of Foraminifera are found in late Cenozoic sediments in cores from Panamint, Danby, and Cadiz dry lakes and in outcrops along the Colorado River from Earp, California, S. to the Blythe area. These indicate a brackish-water environment, either in isolated lakes, in one or more large lakes, or in a marine embayment.--Auth.

2-3332. Baxter, Robert W. A FIRST REPORT OF COAL BALLS FROM THE PENNSYLVANIAN OF NEW BRUNSWICK, CANADA: Can. Jour. Botany, v. 38, no. 4, p. 697-699, July 1960, 8 refs.

The discovery of coal balls in the Pictou (Westphalian C) coal of New Brunswick, Canada, is reported as the first known occurrence of this important form of plant fossilization in North America outside of the well-known deposits in the central United States. Although the specimens collected consisted 99% of unrecognizable degraded organic material, the following genera were found in a state of reasonably good preservation: *Lepidodendron*, *Lepidostrobus*, *Lepidocarpon*, *Psaronius*, *Botryopteris*, *Sphenophyllum*, and *Cardiocarpus*.--Auth.

2-3333. Read, Charles B., and Sergius H. Mamay. UPPER PALEOZOIC FLORAL ZONES OF THE UNITED STATES (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B381-B383, 2 tables, 1960) 3 refs.

Fifteen floral zones are recognized in the upper Paleozoic systems in the United States. The zones of *Adiantites*, *Triphylopteris*, and *Cardiopteris* occur in the Mississippian. The zones of *Neuropteris pocahontas*, *Mariopteris pottsvillea*, *Mariopteris pygmaea*, *Megalopteris*, *Neuropteris tenuifolia*, *Neuropteris rarineris*, *Neuropteris flexuosa*, *Lescuropteris*, and *Danaeites* are characteristic of the Pennsylvanian. In the Permian, the known zones are those of *Callipteris*, the older *Gigantopteris*, *Glenopteris*, and *Supaia* floras, and the younger *Gigantopteris* flora.--Auth.

2-3334. Mamay, Sergius H. GIGANTOPTERIDACEAE IN PERMIAN FLORAS OF THE SOUTHWESTERN UNITED STATES (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B380, 1960)

Three species of Gigantopteridaceae characterize floras of the Belle Plains formation and younger Permian units in N.-central Texas. They closely resemble the Asiatic gigantopterid complex and provide strong evidence of intercontinental floral migration during the late Paleozoic.--Auth.

2-3335. Maslov, V.P., and V.N. Utrobin. DISTRIBUTION OF TERTIARY RHODOPHYCEAE IN THE UKRAINIAN SOVIET SOCIALIST REPUBLIC AND THEIR RELATIONSHIP TO TRANSGRESSIONS OF THE SEA: Akad. Nauk SSSR, Izvestiya, Geol. Ser., in translation, 1958, no. 12, p. 59-76, 7 maps, 3 secs., pub. July 1960, 29 refs.

A geological survey of different parts of the Ukrainian S.S.R. where Tertiary calcareous red algae (Rhodophyceae) have been found. This survey showed that at the Tortonian (upper Miocene) stage a

shallow sea covered the plateau parts of the Ukraine, and the expansion of the red algae corresponded to definite stages of the development of these sea basins. --LC.

2-3336. Naumova, S.N. SPORE-POLLEN COMPLEXES OF UPPER DEVONIAN OF THE RUSSIAN PLATFORM. Translated by Ivan Madirazza: *Internat. Geology Rev.*, v. 2, no. 8, p. 688-704, 6 figs., Aug. 1960, 49 refs.

The introduction and first 5 chapters only of a comprehensive report on the spores and pollen of the upper Devonian of the Russian platform are here presented. A better knowledge of these fossils will provide much needed criteria for stratigraphic delineation in an area of great oil and mineral potential. The Devonian spore-pollen complex is characterized by development of the groups *Triletes* R. of pteridophyte and bryophyte types and gymnosperms. The morphology, botanical affinities, and classification of Devonian spores and pollen are outlined. --M. Russell.

6. GEOPHYSICS

See also: Areal and Regional Geology 2-3160; Structural Geology 2-3241, 2-3245, 2-3249.

2-3338. Kazinsky, V.A. MATHEMATICAL TABLES FOR THE APPROXIMATION OF GEOPHYSICAL ANOMALIES AND REDUCTIONS BY INTERPOLATION POLYNOMIALS. Translated by D.E. Brown: 94 p., tables, New York, Pergamon Press, 1960, ref.

The following tables and methods of procedure have been primarily designed for the reduction and interpretation of underground measurements by gravitational variometer and gravimeter. The usefulness to the tables and methods is, however, by no means confined to underground gravimetry. They can provide valuable assistance in handling overground and marine gravitational measurements and when studying the dividing boundaries of different depth structures in the light of gravity anomalies. The tables are also suitable for approximations of the vertical gradient of gravity produced by any geological body. In addition, they can find a wide application in making models of gravitational field elements, without having recourse to a folio for a selection of majorant curves.

The tables are easy to use and their use is not tied to rigorous conditions regarding the selection of interpolation network, reference surface, and interpolation functions. They permit of variation of the completeness and distribution of the nodal points in accordance with the geometric shape of a body and the field intensity, and thereby enable the degree of convergence of the interpolation process to be raised without increasing the amount of computational work. The computations themselves are of a single type when using the tables, due to the fact that the latter were drawn up on the basis of a single mathematical idea.

Further use may be made of the tables when finding the density of strata and bodies of ore, while the actual principle of double interpolation may be applied for methods of determining mass anomalies in accordance with Ostrogradsky's formula, the coordinates of a centre of gravity using Green's formula,

2-3337. Hertlein, Leo G., and U.S. Grant, IV. THE GEOLOGY AND PALEONTOLOGY OF THE MARINE PLIOCENE OF SAN DIEGO, CALIFORNIA. PART 2a, PALEONTOLOGY (COELENTERATA, BRYOZOA, BRACHIOPODA, ECHINODERMATA): San Diego Soc. Nat. History, Mem., v. 2, p. 73-133, 8 pls., July 7, 1960, refs.

This continues a comprehensive description of the geology and paleontology of the marine Pliocene sequence of the San Diego region. Pt. 1, issued Aug. 30, 1944, contains a description of the general geology. The invertebrate fossils of 4 phyla are systematically described. They are (with families and number of genera) as follows: Coelenterata (*Oculinidae* - 1 gen., *Rhizangiidae* - 1 gen., *Caryophylliidae* - 1 gen., *Dendrophylliidae* - 2 gen.), Bryozoa (31 gen.), Brachiopoda (*Lingulidae* - 1 gen., *Terebratulidae* - 2 gen.), Echinodermata (*Astropectinidae* - 1 gen., *Cidaridae* - 2 gen., *Arbaciidae* - 1 gen., *Echinidae* - 1 gen., *Strongylocentrotidae* - 1 gen., *Echinometridae* - 1 gen., *Dendrasteridae* - 2 gen., *Mellitidae* - 1 gen., *Spatangidae* - 1 gen., *Loveniidae* - 1 gen., *Schizasteridae* - 1 gen.). --M. Russell.

la, or the volume of a working; alternatively the principle can be employed in approximating magnetic field elements, in smoothing out gravity anomalies from gravitational fields with the aid of the mean value theorem for a definite integral, or in investigating the earth's figure in accordance with the Stokes and Meinesz formulae.--Foreword.

The following subjects are discussed: principles underlying the tables; anomalies and reductions of homogeneous bodies of arbitrary shape; anomalies and reductions of nonhomogeneous bodies of arbitrary shape; gravitational effect of irregularities in mine workings; vertical gradient of gravity; approximations for plumb line and geoid-spheroid deviations; magnetic anomalies and reductions of bodies of arbitrary shape; application of Ostrogradsky's formula to the approximation of the mass of a body.

2-3339. Kane, Martin F. TERRAIN CORRECTIONS USING AN ELECTRONIC DIGITAL COMPUTER (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B132-B133, 1960)

Terrain corrections for gravity stations have been computed on the U.S. Geological Survey's Datatron 205. This method has proved faster and inherently more accurate than conventional methods, and promises to be less costly when programmed for the more efficient Datatron 220.--Auth.

2-3340. Sukhodolsky, V.V. AN APPARATUS FOR RECORDING INCLINATIONS AND ACCELERATIONS IN THE DETERMINATION OF GRAVITY AT SEA: Akad. Nauk SSSR, *Izvestiya, Geophysics Ser.*, in translation, 1959, no. 11, p. 1114-1119, 3 illus., 7 diag., pub. Aug. 1960, ref.

The construction of the RNVU apparatus is described. This apparatus is for recording the inclination and acceleration of the mounting of a gravimetric device for determining the gravity at sea. The basic data and characteristics of the apparatus are given. --Auth.

2-3341. Popov, E.I. MARINE MEASUREMENTS WITH THE "GAL" GRAVITY METER: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1959, no. 12, p. 1256-1260, pub. Aug. 1960, 7 tables.

The paper sets out the results of measurements made with marine gravity meters on board a vessel of approximately 6,000 tons displacement. It was shown that the mean quadratic errors of the observation points varied within the limits ± 3.5 to ± 14.0 mgal., depending on the amount of acceleration due to wave disturbance.--Auth.

2-3342. Stackler, W.F. NEW LIGHT ON ISOPACH RESIDUAL VALUES IN GRAVITY INTERPRETATIONS: Oil & Gas Jour., v. 58, no. 33, p. 153, 155, 159, 2 diags., Aug. 15, 1960.

Gravity maps are usually maps of Bouguer values. The main problem in making gravitational maps intelligible to geologists is to separate the various influences. One approach is to use isopach residuals, i.e., the remaining parts of the Bouguer values after taking out effects of regional gravity. Caution must be used in applying the method with residual values calculated with short-cut methods. Station spacing of 1 mi. apart cannot give depth estimates better than ± 1 mi. in depth even though the single values are of very high accuracy.--N. Street.

2-3343. Mabey, Don R. REGIONAL GRAVITY SURVEY OF PART OF THE BASIN AND RANGE PROVINCE (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B283-B285, map, 1960) ref.

In the Basin and Range province an inverse correlation was found between the regional Bouguer anomaly values and the regional topography, with low anomaly values over regional topographic highs. This indicates that there is relative mass deficiency under the regional highlands, and suggests the existence of regional isostatic compensation.--Auth.

2-3344. McCulloh, Thane H. GRAVITY VARIATIONS AND THE GEOLOGY OF THE LOS ANGELES BASIN OF CALIFORNIA (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B320-B325, 3 maps, 2 secs., 2 profiles, 1960) 2 refs.

Bouguer gravity values in the Los Angeles basin were corrected for the effects of geology to a depth of minus 30,000 ft. Some of the remaining residual anomalies result from a partly incorrect density model, but the basin clearly has a residual gravity gradient sloping steeply northeastward, which is ascribed to landward thickening of the crust.--Auth.

2-3345. Mabey, Don R. GRAVITY SURVEY OF THE WESTERN MOHAVE DESERT, CALIFORNIA: U.S. Geol. Survey, Prof. Paper 316-D, p. 51-77, 4 maps (3 in pocket), diag., graph, 7 profiles, 1960, 33 refs.

The western Mojave Desert lies in the SW. corner of the Basin and Range province between the San Andreas and Garlock fault zones. The region is characterized by low hills exhibiting no pronounced trends and by closed alluvium-covered basins. It is underlain by a pre-Tertiary basement complex composed of plutonic igneous rocks enclosing pendants of

metamorphic rocks. The basement complex is overlain by folded, faulted, and eroded remnants of sedimentary, pyroclastic, and volcanic rocks of Tertiary age which were deposited in local basins. Alluvial sediments of Quaternary age cover nearly all the valley areas.

The density contrast that exists in the western Mojave Desert between the Cenozoic rocks and pre-Cenozoic rocks produces gravity anomalies that can be readily defined by gravity surveys. Gravity anomalies resulting from density variations within the pre-Cenozoic basement complex are also evident. To define the major gravity anomalies, a gravity survey consisting of 1,900 gravity stations was conducted over the western Mojave Desert. The data are reduced to the complete Bouguer anomaly and presented on a contour map along with the generalized geology.

The gravity anomaly map indicates the areas in which the basement complex is overlain by large thicknesses of Cenozoic deposits and the order of magnitude of the depth to the basement complex. Gravity anomalies are associated with several major faults. Along profiles across 7 major gravity lows, 2-dimensional theoretical analyses are presented to show the distribution of Cenozoic deposits that could produce the measured anomaly. Lateral density variations within the Cenozoic deposits complicate the interpretation of the anomalies.

Just SE. of the Garlock fault zone the gravity anomalies trend generally parallel to the fault zone. Two major areas of subsidences are indicated along the Garlock fault zone NE. of Tehachapi Pass. One of the subsidences, in Cantil Valley, is estimated to contain about 2 mi. of Cenozoic rocks. In the western part of Antelope Valley, near the junction of the Garlock and San Andreas fault zones, there is a major E.-trending gravity low. The gravity contours in the region of the San Andreas fault zone trend generally parallel to the fault zone, but no important local anomalies associated with the fault zone were recognized. SE. of Rosamond Lake there is a major gravity low trending ENE. An extensive irregularly shaped gravity low occurs N. of Cajon Pass. In the central part of the surveyed area there are several anomalies of smaller areal extent and varying trends.

Information inferred from the gravity data relative to the distribution of the Cenozoic deposits and the structural features effecting these deposits is an aid to the development of the ground-water resources of the region and in exploration for saline deposits in the Cenozoic section. This same information will be helpful in evaluating the possibility of whether important petroleum deposits may occur in the western Mojave Desert.--Auth.

2-3346. Oliver, Howard W. GRAVITY ANOMALIES AT MOUNT WHITNEY, CALIFORNIA (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B313-B315, diag., table, 1960) 13 refs.

Free-air and Bouguer gravity anomalies at Mount Whitney are $+217$ mgals. and -202 mgals. respectively. Heiskanen and Hayford isostatic anomalies are much smaller, but are significantly negative when reasonable assumptions are made regarding the normal thickness of the earth's crust and the depth of compensation. Isostatic compensation of the Mount Whitney region probably involves some combination of the systems proposed by Heiskanen and Hayford.--Auth.

2-3347. Davis, W.E., W.H. Jackson, and Donald H. Richter. APPLICATION OF GRAVITY SURVEYS TO CHROMITE EXPLORATION IN CAMAGÜEY PROVINCE, CUBA (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B133-B136, 2 maps, secs., 1960) ref.

Detailed gravity surveys combined with geologic mapping were used to delineate favorable areas and to determine the location and depths of drill holes in searching for chromite deposits. Sources of 93% of the anomalies investigated were determined by test drilling. Ten deposits were found, containing more than 248,000 tons of chromite.--Auth.

2-3348. Thellier, E., and O. Thellier. THE INTENSITY OF THE EARTH'S MAGNETIC FIELD IN THE HISTORICAL AND GEOLOGICAL PAST: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1959, no. 9, p. 929-948, 2 tables, pub. July 1960, 45 refs.

The authors suggest here a method for investigating the remanent magnetization of ancient vases and bricks. These measurements were used for determining the intensity of the earth's magnetic field of times past during which the investigated objects acquired their magnetization. A consistent and steady decrease of the earth's magnetic moment during the past 2,000 years becomes evident; in some regions this decrease reaches 65%.

The methods proposed by the authors take into consideration all external influences during the magnetization process and provide in particular a way for eliminating the effect of repeated heating, the so-called "temperature cleaning" method.--Auth.

2-3349. Henderson, Roland G. POLAR CHARTS FOR EVALUATING MAGNETIC ANOMALIES OF THREE-DIMENSIONAL BODIES (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B112-B114, 2 charts, sec., diag., 1960)

A new graphical method is presented for rapid computation of total-magnetic intensity anomalies of 3-dimensional bodies. A single chart superimposed upon horizontal sections of the body reduces calculation to a simple counting of chart elements. The counting can be effectively performed on a commercially available optical analogue computer.--Auth.

2-3350. Kazinsky, V.A. APPROXIMATION OF MAGNETIC ANOMALIES AND REDUCTIONS BY INTERPOLATION POLYNOMIALS: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1959, no. 10, p. 1067-1068, 2 figs., table, pub. Aug. 1960.

The use of interpolation polynomials in approximate evaluation of the volume of disturbing magnetic bodies from data obtained by magnetic surveying over a plane surface is discussed. The simplest procedure is the case where a polynomial of the second degree is used for the presentation of the function to be evaluated. A table is given that contains the values of the coefficients to be used in such evaluation. Several figures and graphs are presented. The interpolation polynomials are especially useful where the disturbing body has a complicated shape, or where the magnetization is not uniform over the entire body.--S.T. Vesselowsky (courtesy Geophysical Abstracts 181-393).

2-3351. Andreasen, Gordon E., and Isidore Zietz. MAGNETIC EVIDENCE FOR THE ATTITUDE OF A

BURIED MAGNETIC MASS (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B114-B116, map, 2 profiles, 2 diag., 1960) ref.

A graphical method is described which shows that, despite the ambiguous nature of magnetic interpretations, it is possible, provided certain assumptions are made, to compute the approximate dip of a hypothetical buried dike if the depth to it is known.--Auth.

2-3352. Bower, Margaret E. AEROMAGNETIC SURVEYS ACROSS HUDSON BAY FROM CHURCHILL TO CORAL HARBOUR AND CHURCHILL TO GREAT WHALE RIVER: Canada, Geol. Survey, Paper 59-13, 32 p., map, profiles, 1960, 4 refs.

Two aeromagnetic flights across Hudson Bay were made by the Geological Survey of Canada. Flight 1 was made in June 1955 from Churchill, Manitoba, to Coral Harbour, Southampton Island, a distance of 510 mi. Flight 2, in Aug. 1957, was made from Churchill to Great Whale River, Quebec, a distance of 660 mi. The latter flight passed over the extreme southern end of the Belcher Islands.

On Flight 1, the aircraft was flown at an elevation of about 2,500 ft. above sea level. The average magnetic gradient is -3.2 gammas per mi. in the direction of flight. The rate of decrease varies from 0.45 gammas per mi. near Churchill to 3.75 gammas per mi. at Coral Harbour. On Flight 2, the aircraft was flown at a constant elevation of 1,000 ft. above both land and water. The average magnetic gradient is -1.9 gammas per mi. in the direction of flight. The rate of decrease varies from 1.75 gammas per mi. near Churchill to 2.6 gammas per mi. at Great Whale River, with a region of increasing magnetic intensity about 100 mi. E. of Churchill.

The major part of the text contains aeromagnetic and geomagnetic profiles at a scale of 4 mi. to 1 in. Wherever suitable aeromagnetic anomalies could be found, calculations were made to determine depth to the Precambrian basement. These calculated depths indicate that there is no great thickening of the sedimentary rock in the areas traversed. The most notable feature of Flight 1 is the 6,500-gamma anomaly about 45 mi. from Churchill. It may be caused by a localized belt of Precambrian Fe formation.--A.C. Sangree.

2-3353. King, Elizabeth R., and Isidore Zietz. DETERMINATION OF STRUCTURE IN THE APPALACHIAN BASIN BY GEOPHYSICAL METHODS (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B199-B202, 9 profiles, 1960) 4 refs.

Linear magnetic trends in Kentucky and Tennessee are parallel to structural trends in the north-eastern Appalachians, which indicates that similar structural trends prevail in the crystalline basement. Both magnetic and gravity data indicate a 100-mi. wide block of dense, magnetic rock 8,000 to 10,000 ft. beneath the Appalachian Plateau of southeastern Kentucky and central Tennessee. Linear trends are less distinct farther N., and Paleozoic rocks thicken to the E. and N.--Auth.

2-3354. Zietz, Isidore, Gordon E. Andreasen, and Arthur Grantz. REGIONAL AEROMAGNETIC SURVEYS OF POSSIBLE PETROLEUM PROVINCES IN ALASKA (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p.

B75-B76, map, 1960) 8 refs.

Regional aeromagnetic data in Alaska indicate that thick sections of sedimentary rock underlie much of the Cook Inlet and Kvichak Bay lowlands, the southern half of the Copper River basin, the Arctic Slope, the Koyukuk area, the Kandik area, and large parts of the Yukon-Kuskokwim delta.--Auth.

2-3355. Grantz, Arthur, and Isidore Zietz. POSSIBLE SIGNIFICANCE OF BROAD MAGNETIC HIGHS OVER BELTS OF MODERATELY DEFORMED SEDIMENTARY ROCKS IN ALASKA AND CALIFORNIA (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B342-B347, map, 6 profiles, 1960) 4 refs.

Broad aeromagnetic highs have been recorded over moderately deformed rocks of the Matanuska geosyncline, Alaska, and of the Great Valley, California, but not over adjacent belts of severely deformed sedimentary rocks of similar age. The magnetic highs reflect deeply buried masses of magnetic rock which, if they are structurally competent, could account for the more gentle deformation of the sedimentary rocks of the Matanuska geosyncline and of the Great Valley.--Auth.

2-3356. Allingham, John W. USE OF AEROMAGNETIC DATA TO DETERMINE GEOLOGIC STRUCTURE IN NORTHERN MAINE (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B117-B119, 5 profiles, 1960) 3 refs.

The magnetic patterns in aeromagnetic maps of northern Maine show a general northeasterly structural grain and give information on the continuity and attitudes of igneous features in areas of glacial cover.--Auth.

2-3357. Allingham, John W. INTERPRETATION OF AEROMAGNETIC ANOMALIES IN SOUTHEAST MISSOURI (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B216-B219, map, 7 profiles, 1960) 9 refs.

Aeromagnetic patterns have been correlated with rock type, structural features, topographic form, and the distribution of Pb and Fe deposits in areas of partly exposed Precambrian igneous rock. These correlations can be extended to areas of buried Precambrian basement in which the information may be of economic use.--Auth.

2-3358. Johnson, Robert W., Jr., and Robert G. Bates. AEROMAGNETIC AND AERORADIOACTIVITY SURVEY OF THE CONCORD QUADRANGLE, NORTH CAROLINA (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B192-B195, 2 maps, 1960) 3 refs.

Aeromagnetic and aeroradioactivity data suggest interfingering of gabbro and syenite at the end of 1 of 2 syenite bodies forming a ring structure and indicate that magnetite is concentrated in the gabbro inside the ring structure at the syenite-gabbro contact. The geophysical data disagree in some places with the mapped geology.--Auth.

2-3359. Bromery, Randolph W. PRELIMINARY INTERPRETATION OF AEROMAGNETIC DATA IN THE ALLENTOWN QUADRANGLE, PENNSYLVANIA

(In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B178-B180, map, 1960) 3 refs.

Aeromagnetic contour patterns in the Allentown quadrangle delineate the areal extent of Precambrian rocks. Analysis of magnetic data reveals nearly vertical contacts between crystalline and sedimentary rocks, and indicates areas where the crystalline rocks are relatively thin. An anomaly over sedimentary rocks N. of the Reading Prong locates a buried magnetic mass about a mile below the surface.--Auth.

2-3360. Zietz, Isidore, and Carlyle Gray. GEO-PHYSICAL AND GEOLOGICAL INTERPRETATION OF A TRIASSIC STRUCTURE IN EASTERN PENNSYLVANIA (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B174-B178, map, 3 secs., profile, 1960) 4 refs.

Interpretation of aeromagnetic data suggest that the maximum thickness of the sedimentary rocks S. of Buckingham Mountain is about 7,000 ft., that the displacement on the Furlong fault is about 3,000 ft., and that there is a concealed highly magnetic tabular body 1,000 ft. NW. of the fault.--Auth.

2-3361. Socolow, Arthur A. GEOLOGIC INTERPRETATION OF AEROMAGNETIC MAPS, POTTS-TOWN, WAGONTOWN, DOWNTOWN, COATESVILLE, UNIONVILLE, HONEYBROOK, & PARKESBURG QUADRANGLES: Pennsylvania Geol. Survey, Inf. Circ. 37, 14 p., map, 1960, 8 refs.

Interpretation of maps listed as GeoScience Abstracts 2-793, 2-794, 2-798, 2-801, 2-802, 2-806, 2-807. In the Pottstown quadrangle the area of Triassic sediments shows a simple, uniform magnetic pattern. A narrow positive magnetic anomaly occurs along the diabase contact due to contact metamorphism of the ferruginous sediments. Over the site of the old French Creek Fe mines there is a distinct positive anomaly, though there is no indication of any significant quantity of the magnetite ore remaining. Several small anomalies over gneisses and intrusives indicate minor noneconomic occurrences of magnetite.

In the Wagontown quadrangle, which consists largely of igneous and metamorphic rocks, a belt of small, positive magnetic anomalies rings an anorthosite area 6 mi. in diameter; this indicates an Fe segregation in the border zone, though not of economic significance. Some small positive anomalies are associated with minor magnetite concentrations in areas of both gabbro and granodiorite.

The Downtown quadrangle exhibits no distinct magnetic pattern, with only a few minor anomalies over the areas of crystalline rocks.

In the northern third of the Coatesville quadrangle the magnetic pattern is uniform and simple over the Cambro-Ordovician sediments and over the chlorite phase of the Wissahickon formation. In the southern two-thirds of the quadrangle many positive magnetic anomalies occur over minor magnetite concentrations in the Peters Creek formation and the oligoclase facies of the Wissahickon formation.

In the Unionville quadrangle the granitic gneiss and the chlorite phase of the Wissahickon formation show little magnetic expression. Several positive magnetic anomalies occur over the oligoclase phase of the Wissahickon formation due to minor occurrences of magnetite. A positive anomaly is also associated with a local serpentine mass.

Though the Honeybrook quadrangle includes sedimentary, metamorphic, and igneous rocks, the magnetic patterns are simple and remarkably uniform. Only a few minor anomalies are associated with gneisses and serpentine.

The lower Paleozoic sediments and the chloritic phase of the Wissahickon formation in the Parkesburg quadrangle exhibit a simple, uniform magnetic pattern. A couple of positive magnetic anomalies are associated with the Peters Creek schist and the oligoclase phase of the Wissahickon formation, in each case due to minor amounts of disseminated magnetite.--Auth.

2-3362. Socolow, Arthur A. GEOLOGIC INTERPRETATION OF AEROMAGNETIC MAPS, TEMPLE, FLEETWOOD, MANATAWNY, READING, BIRDSBORO, & BOYERTOWN QUADRANGLES: Pennsylvania Geol. Survey, Inf. Circ. 38, 26 p., map, 1960, 14 refs.

Interpretation of maps listed as GeoScience Abstracts 2-791, 2-792, 2-796, 2-800, 2-803, 2-805. Temple quadrangle: The SE. part of the quadrangle shows numerous positive magnetic anomalies; these are developed over the gneisses and infolded quartzite of the Reading Prong which contain zones of disseminated, noneconomic magnetite concentrations. The remainder of the quadrangle consists of sediments which give a low, uniform magnetic pattern.

Fleetwood quadrangle: The northern and southeastern portions are areas of Cambro-Ordovician sediments which develop only a simple magnetic pattern. The rest of the quadrangle exhibits many positive magnetic anomalies over granitic and hornblende-rich gneisses due to minor concentrations of magnetite. Some old Fe mines were attempted here but failed for lack of quality and quantity of ore; these conditions are substantiated by the magnetic data.

Manatawny quadrangle: This is an area of granitic and hornblende-rich gneisses with a record of over 100 Fe mines before the turn of the century. The mines yielded over a half million tons of magnetite ore a year, of 30-52% Fe content; the ore zones were as much as 35 ft. thick, dipping steeply SE. The presence of high-grade ore still in place and the existence of an anomaly of 3,000 gammas amplitude over Rittenhouse Gap commend this area for further exploration. Two major magnetic anomalies just NE. of Rittenhouse Gap are also over magnetite-bearing gneiss which merits attention. The rest of the quadrangle has numerous positive magnetic anomalies of lesser magnitude which can be associated in the field with old mining attempts in the magnetite-bearing gneisses. The magnetics reveal major structural trends as well.

Reading: The Cambro-Ordovician sediments of the northwestern part of the quadrangle give a sparse, simple magnetic pattern, while in the NE. portion there are numerous positive magnetic anomalies developed over the gneisses and quartzite which make up the Reading Prong. Minor concentrations of magnetite and iron silicates in the gneisses are apparently responsible for the anomalies. Very significant is the absence of any magnetic anomaly over Neversink Mountain; the indications are that this prominent hill, made up of gneisses and quartzite, may be a rootless klippe. In the southern half of the quadrangle minor anomalies mark the locations of the former Fritz Island and Raudenbush mines; these were replacement magnetite ores where Cambro-Ordovician limestones and Triassic

limestone conglomerates were in close proximity to Triassic diabase. No significant remaining Fe mineralization is indicated here.

Birdsboro quadrangle: The eastern half of the area is underlain by lower Paleozoic and Triassic sediments; these manifest a simple, uniform magnetic pattern. The western half is underlain by gneisses which show many positive magnetic anomalies due to minor magnetite and iron silicate concentrations. The horseshoe-shaped diabase sill E. of Reading shows a pronounced negative anomaly on its N. limb and a sharp positive anomaly on its S. limb, possibly a result of magnetic perm though a small magnetite mine once operated near the S. limb. Pronounced positive anomalies occur over the steeply dipping Triassic diabase dike in the SW. and over the hornblende gneiss at Spies Church.

Boyertown quadrangle: The Triassic sediments of the southern half of the area give a simple, uniform magnetic pattern. The northern half of the quadrangle exhibits many positive magnetic anomalies due to minor magnetite concentrations in the gneisses and due to the old magnetite mines at and near Boyertown. The presence of Paleozoic limestones and Triassic limestone conglomerate in proximity to Triassic diabase makes this a favorable geologic environment for potential mineralization; the old mines are evidence that such mineralization occurred. The magnetic data indicate that some ore still remains; how much is still a question.--Auth.

2-3363. Socolow, Arthur A. GEOLOGIC INTERPRETATION OF AEROMAGNETIC MAPS, EASTON & RIEGELSVILLE QUADRANGLES: Pennsylvania Geol. Survey, Inf. Circ. 39, 7 p., map, 1960, 3 refs.

Interpretation of maps listed as GeoScience Abstracts 2-795, 2-804. In the Easton quadrangle the sedimentary areas show relatively low, uniform magnetic patterns while the areas of crystalline rocks are distinguished by a large number of magnetic anomalies. Field examination of the anomaly areas shows disseminated magnetite to be locally present in the crystalline rocks; there is a marked correlation between the topographic highs and the magnetite-bearing lithology. Neither the geology nor the magnetometer data suggest economic Fe concentrations.

In the Riegelsville quadrangle some distinct positive magnetic anomalies are associated with areas of gneiss, particularly at the sites of some former Fe mines. The presence of Triassic limestone conglomerate, Paleozoic limestones, and Triassic intrusives in the area offer a favorable geologic environment for possible mineralization. However, the magnetic data at these critical localities offers only slight encouragement for further exploration.--Auth.

2-3364. Socolow, Arthur A. GEOLOGIC INTERPRETATION OF AEROMAGNETIC MAPS, HATBORO & LANGHORNE QUADRANGLES: Pennsylvania Geol. Survey, Inf. Circ. 40, 7 p., map, 1960, 3 refs.

Interpretation of maps listed as GeoScience Abstracts 2-797, 2-799. The Hatboro and Langhorne quadrangles each exhibit 2 contrasting magnetic patterns. In the northern half of the quadrangles the Triassic sediments result in few, widely spaced magnetic contours. In the southern half of the area a number of elongate, positive magnetic anomalies are developed over an easterly trending belt of gneiss. The anomalies indicate minor, noneconomic

concentrations of magnetite and iron silicates in the gneiss. It is noteworthy that the bands responsible for the anomalies strike in a northeasterly direction, while the over-all belt of gneiss has a more easterly trend which was developed in late Paleozoic time. Where the magnetic zones in the gneiss are overlain by the Triassic sediments, the anomalies may still be observed in a modified form.--Auth.

2-3365. Schneerson, B.L. THE CAUSES OF THE INTENSIVE MAGNETIC ANOMALIES AT KURSK: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1959, no. 10, p. 1065-1066, 2 figs., pub. Aug. 1960, 7 refs.

The possibility of incorrect interpretation of magnetic measurements made by different geophysicists in various parts of the Kursk magnetic anomaly is pointed out. Much lower values of K (the magnetic susceptibility) and of Z (the vertical component) of the magnetic field have been determined by some investigators. If the latter results are correct, the very optimistic conclusions on the commercial value of this anomaly must be essentially reduced.--S.T. Vesselowsky (courtesy Geophysical Abstracts 181-400).

2-3366. Doell, Richard R., and Robert E. Altenhofen. PREPARATION OF AN ACCURATE EQUAL-AREA PROJECTION (In: U.S. Geological Survey. Geological Survey Research 1960: Its Prof. Paper 400-B, p. B427-B429, diag., 1960) 4 refs.

The need for, and previous lack of, a precise graphical means for solving problems of spherical trigonometry inherent in paleomagnetic research led us to design and construct a Lambert equal-area projection with an accuracy of one-tenth degree. The net should have other applications.--Auth.

2-3367. Doell, Richard R., and Allan V. Cox. PALEOMAGNETISM, POLAR WANDERING, AND CONTINENTAL DRIFT (In: U.S. Geological Survey. Geological Survey Research 1960: Its Prof. Paper 400-B, p. B426-B427, 1960)

Paleomagnetic results from the late Tertiary rocks strongly support the dynamo theory for the earth's magnetic field and exclude extensive polar wandering during late Tertiary time; results from older rocks have not yielded thus far any conclusive evidence regarding continental drift.--Auth.

2-3368. Bath, Gordon D. MAGNETIZATION OF VOLCANIC ROCKS IN THE LAKE SUPERIOR GEOSYNCLINE (In: U.S. Geological Survey. Geological Survey Research 1960: Its Prof. Paper 400-B, p. B212-B214, map, 3 profiles, 1960) 5 refs.

The magnetic effects of the huge mass of Keweenaw lava flows in the Lake Superior geosyncline are due to a combination of induced and remanent magnetization.--Auth.

2-3369. Makarova, Z.V. LOCATION OF THE MAGNETIC POLE DURING THE TRIASSIC PERIOD BY MEANS OF REMANENT MAGNETIZATION OF BASALTIC TRAP ROCK IN THE ENISEI REGION: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1959, no. 10, p. 1081-1082, table, pub. Aug. 1960, 9 refs.

The direction of the natural remanent magnetization was determined for Triassic gabbros from the lower Tunguska River valley in Siberia. The coordinates of the pole for these rocks are: $\phi = 88^\circ$, $\lambda = 148^\circ$. Comparison is made with data from rocks of similar age from England and Arizona. Agreement is close between Siberian and English localities but these are quite divergent from the position indicated by the Arizona locality.--S.T. Vesselowsky (courtesy Geophysical Abstracts 181-388).

2-3370. Pospelova, G.A. REMANENT MAGNETIZATION OF TERTIARY AND QUATERNARY VOLCANIC ROCKS: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1959, no. 11, p. 1126-1130, 8 figs. incl. map, 2 tables, pub. Aug. 1960, 7 refs.

The author investigates the remanent magnetization of Tertiary and Quaternary lavas in Armenia, the Kurile Islands, and Kamchatka. It is established that the Quaternary rocks display normal magnetization, the rocks contemporaneous with the Pliocene/Pleistocene boundary, however, reverse magnetization. This agrees with the assumption of inversion of the earth's magnetic field. The pole positions during the time of formation of these rocks are calculated and coincide well with data by other investigators. Based on these results, the age of certain rocks is determined more accurately.--Auth.

2-3371. Pechersky, D.M. AGE DIFFERENTIATION AND AGE CORRELATION OF EFFUSIVES IN THE BASINS OF THE BOLSHOI ANYUI AND OMOLONA RIVERS: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1959, no. 12, p. 1228-1233, 3 figs., 5 tables, pub. Aug. 1960, 7 refs.

An attempt is made at subdivision and correlation of the extrusive rocks of the Omolon massif and the Oloy downwarp in northeastern U.S.S.R. according to geochemical and paleomagnetic data. It was found that the ratio of remanent magnetization (I_n) and susceptibility (χ) is different for the extrusive rocks of different geologic ages. As an example, I_n in Paleozoic extrusives remains practically unchanged with increases in χ , whereas in Mesozoic intrusives it rises considerably with increases in χ .--A.J. Shneiderov (courtesy Geophysical Abstracts 181-389).

2-3372. Markhinin, E.K., and G.A. Pospelova. SOME RESULTS OF PALEOMAGNETIC INVESTIGATIONS IN THE KURILE ISLANDS: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1959, no. 10, p. 1079-1080, 2 figs., pub. Aug. 1960, 3 refs.

The magnetic properties were determined for rocks of the Kurile Islands. Rocks of Cretaceous, Miocene, early Quaternary, and late Quaternary age are included in the investigation. The position of the specimens was marked in place, and the remanent magnetization was measured with a Dolginov magnetometer. From this value the total vector (I_n) of the magnetization, the declination (D) and the inclination (I) were computed. The vectors of remanent magnetization of specimens taken from recent lava coincide with the vectors of the present magnetic field. The early Quaternary and some Pliocene units show an inverse remanent magnetization, but the vectors differ considerably. The Miocene volcanic rocks give divergent results; some have an inverse direction, and others have the same direction as the present magnetic field. The results are, in

general, unreliable, owing to the probability of tectonic activity having changed the position of the formations.--S.T. Vesselowsky (courtesy Geophysical Abstracts 181-390).

2-3373. Vladimirov, N.P., and N.N. Nikiforova. ON THE VARIATION SPECTRUM OF THE NATURAL ELECTROMAGNETIC FIELD OF THE EARTH: Akad. Nauk SSSR, *Izvestiya, Geophysics Ser.*, in translation, 1959, 4 figs., pub. Aug. 1960, 3 refs.

Results of investigating the variation spectrum of the earth's natural electromagnetic field are reported. A continuous spectrum was found within the frequency range 0.3-100 c.p.s., and the diurnal distribution of frequency is practically uniform. Intensity of field variation depends on frequency and time of day; the amplitude increases with decreasing frequency and is smaller at night. The mean amplitude of the horizontal components of the earth's electromagnetic field was found to be 0.1 mv. per km., and the amplitudes of the magnetic field components to be 10^{-7} - 10^{-8} eötvös.--A.J. Shneiderov (courtesy Geophysical Abstracts 181-82).

2-3374. Dyakonov, B.P. THE DIFFRACTION OF ELECTROMAGNETIC WAVES BY A SPHERE LOCATED IN A HALF-SPACE: Akad. Nauk SSSR, *Izvestiya, Geophysics Ser.*, in translation, 1959, no. 11, p. 1120-1125, fig., pub. Aug. 1960, 7 refs.

The problem is solved of the diffraction of electromagnetic waves at a sphere of arbitrary conductance which is located in a conducting half-space with a plane boundary. The solution is obtained in a form that is applicable to calculations that are relevant to the low-frequency method of electric geophysical exploration.--Auth.

2-3375. Matveev, B.K., and N.G. Shkabarnya. ELECTRICAL PROFILING ABOVE A SPHERE SITUATED NEAR THE BOUNDARY BETWEEN TWO MEDIA: Akad. Nauk SSSR, *Izvestiya, Geophysics Ser.*, in translation, 1959, no. 10, p. 1060-1064, 4 figs., pub. Aug. 1960, 7 refs.

The problem of the disturbance produced in an electric field by a sphere buried near the plane boundary of 2 media with different electric properties is analyzed, and an approximate solution is presented. A conductive sphere produces more pronounced anomalies of apparent resistivity than does a non-conductive sphere. Anomalies are better observed when the electric profiling is made with an asymmetric 3-electrode arrangement. The formulas derived can also be used in estimating the effect of caverns, sinkholes, and other such features.--S.T. Vesselowsky (courtesy Geophysical Abstracts 181-180).

2-3376. Tikhonov, A.N., and others. THE RESOLUTION POWER OF THE ELECTROMAGNETIC SOUNDING METHOD IN THE PRESENCE OF NON-CONDUCTIVE STRATA: Akad. Nauk SSSR, *Izvestiya, Geophysics Ser.*, in translation, 1959, no. 10, p. 1038-1040, 8 graphs, pub. Aug. 1960, ref.

The possibilities of the electromagnetic sounding method in the presence of nonconductive strata are examined. It has been demonstrated that new possibilities are opened up by the use of alternating electromagnetic fields instead of the direct current method.--Auth.

2-3377. Tikhonov, A.N., and V.I. Dmitriev. ON THE POSSIBILITY OF USING THE INDUCTION METHOD OF ELECTRICAL PROSPECTING FROM THE AIR FOR GEOLOGICAL MAP-MAKING: Akad. Nauk SSSR, *Izvestiya, Geophysics Ser.*, in translation, 1959, no. 10, p. 1053-1055, diag., 7 graphs, pub. Aug. 1960, 2 refs.

Determination of the characteristics of alluvium from measurement of the vertical component of the magnetic field at various frequencies is discussed. Two cases are presented in detail: 1) when the resistivity of the alluvium is considerably less than that of the underlying rock, and it is possible to treat the problem as a conductive stratum spread on an insulating foundation; and 2) where the alluvium is very thin (as compared with the length of the wave) and is spread over a homogeneous conductive semispace. The solution of both cases is given in algebraic form as well as in the form of graphs.--S.T. Vesselowsky (courtesy Geophysical Abstracts 181-191).

2-3378. Enenshtein, B.S., and others. SOME DATA ON SOUNDINGS BY THE METHOD OF PULSING AN ELECTRIC CURRENT IN THE EARTH: Akad. Nauk SSSR, *Izvestiya, Geophysics Ser.*, in translation, 1959, no. 10, p. 1056-1059, 3 diag., 3 graphs, pub. Aug. 1960, 2 refs.

The possibility of obtaining very reliable information on the geology of an area from the curves showing the build-up of current in the ground produced by a d-c impulse is discussed. Instruments with very little inertia are essential, and the electrode spacing in the usual MABN arrangement must be made long enough. A portable d-c impulse generator that gives a sharp step-shaped impulse in about 10^{-3} sec. and a d-c amplifier are used. Filters are also necessary for the exclusion of different disturbances as, for instance, the signals coming from radio stations. The described method of prospecting is more economical than the usual electric method with 4 electrodes. Several wiring diagrams of the apparatus are given. Theoretically computed nomograms for the interpretation of field results must be prepared.--S.T. Vesselowsky (courtesy Geophysical Abstracts 181-195).

2-3379. Frischknecht, Frank C., and E.B. Ekren. MAPPING CONDUCTIVE STRATA BY ELECTROMAGNETIC METHODS (In: U.S. Geological Survey. Geological Survey Research 1960: Its Prof. Paper 400-B, p. B121-B125, map, 6 profiles, 1960) 2 refs.

Conductive black slate and Fe formation, which are fairly common among metamorphic rocks, may be traced as marker beds by electromagnetic methods in areas of extensive glacial cover.--Auth.

2-3380. Guerrero, E.T., and F.M. Stewart. HOW TO FIND INTERSTITIAL-WATER SATURATION FROM ELECTRIC-LOG DATA: *Oil & Gas Jour.*, v. 58, no. 38, p. 113-114, 2 figs., Sept. 19, 1960, 7 refs.

The method of estimating true resistivity from electric log data is outlined together with the calculation of interstitial water saturation from these estimates. The limitations are discussed.--N. Street.

2-3381. Jones, Robert E. USING ELECTRIC LOG EVALUATION IN EXPLORING FOR ROCKY MOUNTAIN PETROLEUM TRAPS: *Oil & Gas Jour.*, v. 58,

no. 29, p. 142-145, 4 figs., July 18, 1960, ref.

Pt. 1 of a 2 pt. article. Although electric logs have been used for years, the large majority have not been used to evaluate physical formation parameters. Log evaluation determines a relative factor of formation-water salinity, and secondly a relative rating as to quality of hydrocarbon shows in the pore space. These parameters are used to delineate formation traps.--N. Street.

2-3382. Jones, Robert E. PROPER EVALUATION OF ELECTRIC LOGS IS A BIG STEP TOWARDS DETERMINING WHETHER TO DRILL A NEW WELL: Oil & Gas Jour., v. 58, no. 30, p. 294, 297-298, 3 maps, table, July 25, 1960.

Pt. 2 of a 2 pt. article on electric logs (pt. 1, see above). The delineation of formation trapping in clean and fairly clean porous formations is possible because higher concentrations of water salinity are present within formation traps since they are isolated from flushing action of water movements. Consistent techniques of SP log calculation show the changes in water salinity.--N. Street.

2-3383. Anderson, L.A. ELECTRICAL PROPERTIES OF SULFIDE ORES IN IGNEOUS AND METAMORPHIC ROCKS NEAR EAST UNION, MAINE (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B125-B128, diag., 3 logs, 1960)

Electric logs of the rocks surrounding a sulfide deposit near East Union, Maine, provided information to define the zones containing sulfides in excess of 5% by weight. Laboratory measurements show that induced polarization is an excellent method for estimating the relative sulfide concentration.--Auth.

2-3384. Zablocki, C.J. MEASUREMENTS OF ELECTRICAL PROPERTIES OF ROCKS IN SOUTH-EAST MISSOURI (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B214-B216, 4 logs, table, 1960) ref.

Self-potential, electrical-resistivity, magnetic-susceptibility, and induced-polarization measurements were made in 6 diamond drill holes in Upper Cambrian sedimentary rocks and a complex of Precambrian metavolcanic and intrusive rocks in SE. Missouri. The wide ranges in the measured properties are related to the differences in rock texture and composition.--Auth.

2-3385. Keller, George V. ELECTRICAL PROPERTIES OF ZINC-BEARING ROCKS IN JEFFERSON COUNTY, TENNESSEE (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B128-B132, 3 diags., logs, table, 1960) 4 refs.

Electric logs from several drill holes penetrating sphalerite ore show that resistivity in the ore zone is reduced from the normal values for surrounding rocks by brecciation, and that electrical methods of exploration should be effective in locating brecciated ore.--Auth.

2-3386. Pasechnik, I.P., and N.E. Fedosenko. MODERNIZATION OF THE SVK AND SGK TYPE SEISMOGRAPHS: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1959, no. 12, p. 1294-

1299, 6 figs., 2 tables, pub. Aug. 1960, 8 refs.

The vertical and horizontal SVK-M and SGK-M seismographs are improved models of the SVK and SGK types. The magnetic system is spherical, and the flat coils are cylindrical. It is shown that these new seismographs can produce well-defined seismic records at epicentral distances over 7,000 km. for earthquakes of intensity $M = 5$, and over 2,600 km. for those with $M = 4$. The unimproved models cannot register earthquakes of $M = 4$ having epicentral distances more than 600 km.--A.J. Shneiderov (courtesy Geophysical Abstracts 181-144).

2-3387. Obukhov, V.A. THE HIGH SENSITIVITY LS-1 LABORATORY SEISMOSCOPE: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1959, no. 11, p. 1147-1153, 7 figs., pub. Aug. 1960, 19 refs.

A principle of operation and arrangement of this seismoscope is discussed. The amplification coefficient of the seismoscope amplifier is equal to 2.8×10^6 . The amplitude of the electric pulses from the emitter is 1,200 volts. This device permits the modeling of low-intensity wave processes with high accuracy, an example of which is a record of a diffracted wave.--Auth.

2-3388. Obukhov, V.A. IMPROVING THE UZS-2 SEISMOSCOPE (31): Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1959, no. 10, p. 1075-1078, 5 figs., pub. Aug. 1960, 14 refs.

A new wide range frequency amplifier has been added to the UZS-2 (31) seismoscope, thereby increasing the frequency range of the instrument from 14-70 to 14-760 kc. The amplification of the seismoscope is increased to 350,000 in the frequency range of 20-400 kc. The wiring diagram of the improved instrument is given.--S.T. Vesselowsky (courtesy Geophysical Abstracts 181-458).

2-3389. Stewart, Samuel W., R.B. Hofmann, and W.H. Diment. SOME AFTERSHOCKS OF THE HEBGEN LAKE, MONTANA, EARTHQUAKE OF AUGUST 1959: (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B219-B221, map, graph, 1960) 5 refs.

More than 600 aftershocks of Richter magnitude 0.4 to 3.7 were recorded by a portable seismograph during 22 hours of intermittent operation at a single station from 3.8 to 6.1 days after the main shock. More than half of the 30 epicenters, whose locations were determined from 2 stations, are aligned along a northerly trend that does not correlate with surface effects of the earthquake or with known geologic structure. Most of the other epicenters are in the area of known surface deformation.--Auth.

2-3390. Ez, V.V. THE TECTONIC CHARACTERISTICS OF THE AREA OF ORIGINATION OF DEEP-SEATED EARTHQUAKES IN THE EASTERN CARPATHIANS: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1959, no. 12, p. 1285-1288, 5 maps, pub. Aug. 1960, 7 refs.

The tectonism of the highly seismic Fokshani area of Rumania is analyzed with the aid of topographic maps in combination with the isostatic anomaly map (in Airy reduction for a 30 km. normal thickness of the crust). The data from these maps, the apparent change in the direction of the flow of rivers in the

region during recent geologic times, and a considerable development of swamps along the Seret, Ramnicul, and Putna rivers indicate a current subsidence of the region adjacent to Fokshani. The conclusion was reached that an intense subsidence of the basement is taking place in the Fokshani region and that the epicentral zone of deep earthquakes in the eastern Carpathians coincides with the western part of the deep Fokshani depression.--A. J. Shneiderov (courtesy Geophysical Abstracts 181-246).

2-3391. Leonov, N.N. THE 1955 ULUGCHAT EARTHQUAKE: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1959, no. 11, p. 1199-1203, 2 maps, graph, pub. Aug. 1960, 11 refs.

On Apr. 15, 1955, a strong earthquake occurred just N. of the city of Ulugchat. Three shocks occurred at $3^h40'$, $4^h12'$, and $4^h14'$ Greenwich time. The geographic coordinates of the epicenter were determined as $\phi = 39^{\circ}9'N.$; $\lambda = 74^{\circ}6'E.$ The earthquake reached an intensity of 7 (Russian scale) near the village of Alaykél. Damage to buildings was very extensive, especially to dwellings of poor construction built of adobe bricks. It is interesting to note that 60-90 min. after the Ulugchat earthquake, a new local, very shallow shock occurred in the region of Katta-Kurgan some 75-100 km. NE. Leonov does not consider this as an ordinary aftershock but rather as a separate earthquake triggered by the Ulugchat earthquake. Such "induced" earthquakes are known to have occurred in the Caucasus, northern Tien-Shan, and other regions. The depth of the Ulugchat focus was determined by different investigators as ranging from 80-120 km.--S.T. Vesselowsky (courtesy Geophysical Abstracts 180-43).

2-3392. Shirokova, E.I. DETERMINATION OF THE STRESSES EFFECTIVE IN THE FOCI OF THE HINDU-KUSH EARTHQUAKES: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1959, no. 12, p. 1224-1227, 2 figs., 2 tables, pub. Aug. 1960, 6 refs.

The author investigates the distribution of forces in the foci of the Hindu-Kush earthquakes located near $\phi = 36-1/2^{\circ}N.$ and $\lambda = 70-1/2^{\circ}E.$ at ~ 200 km. depth. It was discovered that the compressive focal stresses act almost horizontally ($\approx 10^{\circ}$) in NNW.-SSE. direction ($\sim 350^{\circ}$), and the tensile stresses almost vertically ($\approx 85^{\circ}$) in SSW.-NNE. direction.--Auth.

2-3393. Kondorskaya, N.V., and G.A. Postolenko. ANALYSIS OF OBSERVATIONS ON EARTHQUAKES IN THE KURILO-KAMCHATKA REGION: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1959, no. 10, p. 1033-1037, map, 4 graphs, pub. Aug. 1960, 9 refs.

Based on an analysis of observations, the authors assign epicenters to individual zones, the boundaries of which coincide in the Kurile Islands region with the axes of tectonic troughs and transverse fault lines. The characteristics of each epicentral zone are described, and the distribution of the earthquakes according to depth is discussed.--Auth.

2-3394. Petrushevsky, B.A. ON THE INVESTIGATIONS OF THE SEISMICITY OF THE TERRITORY OF THE PEOPLE'S REPUBLIC OF CHINA: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1959, no. 12, p. 1217-1223, map, pub. Aug. 1960, 5 refs.

A brief account of the seismogeologic relationships in the [Kansu] corridor ($36^{\circ}-40^{\circ}N.$, $100^{\circ}-107^{\circ}E.$ approximately), northwestern China, is given. Tectonic characteristics of the corridor are discussed, and the area is subdivided into 4 tectonic zones. This is one of the most active areas seismically in China, having records of earthquakes of magnitude 11 (1920) and 12 (1927). The epicenters lie in a zone more or less along the boundary of the Nan Shan [mt. range] with the plains areas to the NE. The Nan Shan, known for Neogene tectonism, has a low seismicity.--A.J. Shneiderov (courtesy Geophysical Abstracts 181-103).

2-3395. Balakina, L.M. THE DISTRIBUTION OF STRESSES EFFECTIVE IN EARTHQUAKE FOCI IN THE NORTHWESTERN PACIFIC: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1959, no. 11, p. 1131-1135, 2 maps, table, pub. Aug. 1960, 5 refs.

The determination of stresses occurring in the foci of 24 earthquakes in the northwestern Pacific is used for delineating a series of regularities in the distribution of main stresses in the crust and upper parts of the earth's mantle in a given seismic region.--Auth.

2-3396. Khovanova, R.I. ON T-PHASE AND ITS POSSIBLE RELATION TO TSUNAMI: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1959, no. 10, p. 1069-1071, 2 figs., pub. Aug. 1960, 15 refs.

It has been found by many investigators that tsunami often seem to be related to the seismic T-waves. These waves, produced by underwater earthquakes, are characterized by a short period (0.5-1.0 sec.) and are not recorded by Golitzin and Benioff long-period seismographs. The suggestion is made that the T-phase is a group of converted waves. This group propagates from the earthquake focus to the surface of the ocean floor as P or S(SV) waves with the usual velocity, then follows the deep-water acoustic channel as a longitudinal wave with a velocity of 1.5 km/s. and on the continent is transformed into P- or S-waves. It is hoped that further investigation of the nature of the T-phase will shed more light on the relationship between the T-phase and tsunami.--S.T. Vesselowsky (courtesy Geophysical Abstracts 181-129).

2-3397. Savarensky, E.F. AN ELEMENTARY EVALUATION OF THE INFLUENCE OF A LAYER ON VIBRATIONS OF THE EARTH'S SURFACE: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1959, no. 10, p. 1029-1032, 2 diagrs., 2 graphs, pub. Aug. 1960, 2 refs.

The influence of a damping layer on a vertically incident longitudinal wave or on an SH wave striking in some arbitrarily chosen direction is evaluated. The evaluation is important for seismic zoning.--Auth.

2-3398. Lossovsky, E.K. ON THE ACCURACY OF THE MEAN-VELOCITIES METHOD IN THE SEISMICS OF REFRACTED WAVES: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1959, no. 12, p. 1289-1291, 2 graphs, pub. Aug. 1960, 8 refs.

The interpretation of traveltime curves of waves refracted at a boundary overlain by a medium of higher velocity of elastic oscillations is discussed. The inverse problem of interpretation by the method of mean velocities is analyzed. It was found that this method of traveltime curve interpretation allows a well-defined solution of the problem. The method is extended to the interpretation of traveltime curves of seismic waves refracted at a horizontal boundary in which velocities increase linearly with increasing depth. It is shown that the maximum possible error ΔH in the depth H of the refracting boundary, determined by the method discussed, is 7.5%, whereas the probable error was found to be not more than 6%.--A.J. Shneiderov (courtesy Geophysical Abstracts 181-126).

2-3399. Podyapolsky, G.S. AN APPROXIMATE EXPRESSION FOR THE DISPLACEMENT IN THE VICINITY OF THE PRINCIPAL FRONT WHEN THE ANGLE BETWEEN THE RAY AND AN INTERFACE IS SMALL: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1959, no. 12, p. 1238-1244, 2 figs., pub. Aug. 1960, 3 refs.

An exact solution of the problem of the propagation of an elementary wave of arbitrary type, generated by an axially symmetric point source in a parallel-layered laminar elastic medium, is used to derive an approximate expression for the displacement in the vicinity of the principal front when the path of the seismic wave in one of the layers is inclined at only a small angle to the interface. The general formula is applied in the particular case of a wave that is refracted on entering a medium with a higher longitudinal wave propagation velocity.--Auth.

2-3400. Yanovskaya, T.B. AN INVESTIGATION OF DISPERSING SURFACE WAVES IN THE REGION OF MINIMUM GROUP VELOCITY: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., 1959, no. 12, p. 1234-1237, 7 figs., pub. Aug. 1960, 4 refs.

An asymptotic expression is obtained for the displacement in dispersing surface waves which is valid in a rather wide region in the neighborhood of the minimum group velocity. It is shown that this expression includes both the result obtained by the stationary phase method and the expression for the Airy phase. A formula is given for the first correction term. As an example of the application of the formulas obtained, seismograms are calculated near the minimum group velocity for several amplitudes.--Auth.

2-3401. Savarensky, E.F. ON THE DETERMINATION OF GROUP AND PHASE VELOCITIES FROM OBSERVATIONS: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1959, no. 11, p. 1102-1107, 6 figs., 3 tables, pub. Aug. 1960, 10 refs.

The paper analyzes the physical elements and methods for determining group and phase velocities of seismic surface waves.--Auth.

2-3402. Keylis-Borok, V.I., and A.S. Munin. MAGNETOELASTIC WAVES AND THE BOUNDARY OF THE EARTH'S CORE: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1959, no. 11, p. 1089-1095, 4 graphs, table, pub. Aug. 1960, 12 refs.

The dispersion, damping, polarization and excita-

tion conditions for plane magnetoelastic waves are investigated. As the field strength H_0 increases, the damping of waves passes a certain maximum and then tends towards zero. Two waves are possible in strong fields: a slow wave, the velocity of which lies between the velocities of longitudinal and transverse elastic waves, and a fast wave, the velocity of which is proportional to H_0 . It is only in the slow wave that there is intensive mechanical vibration. Whether these waves are close to longitudinal or transverse waves is dependent on the orientation of the field in relation to the direction in which the waves are propagated and is practically independent of whether the initial impulse was longitudinal or transverse. The observed distribution for the velocities of seismic waves in the D'' layer can be explained by assuming a linear increase in the gradient k/ρ and a decline in u/ρ compensated by the magnetic field.--Auth.

2-3403. Neprochnov, Yu. P., and G.B. Udintsev. PROPAGATION VELOCITY MEASUREMENTS OF ELASTIC WAVES IN UNCONSOLIDATED MARINE DEPOSITS: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1959, no. 11, p. 1193-1194, 2 figs., pub. Aug. 1960, 6 refs.

The Institute of Oceanology of the U.S.S.R. Academy of Sciences has made determinations of the velocity of propagation of elastic waves over measured distances in sediments on the ocean bottom. The same determinations were also made in the laboratory on specimens taken from these deposits. For the production and reception of impulses an ultrasonic seismoscope designed by the Institute of Physics of the Earth has been used.

The apparatus for the measurements at sea consisted of a frame on which an emitter and a receiver of impulses were rigidly fixed at a desired distance and provided with crystals of Seignette's salt and knives which could penetrate into the bottom to a certain depth. The first series of experiments was made in 1957 in the Sea of Japan and in the adjoining open areas of the Pacific Ocean. Later the measurements were continued on the bottom of the Black Sea. The measurements were made mostly on argillaceous and silt deposits. The velocity of the acoustic waves was found to range from 1,430 to 1,620 m. per sec. In some cases the acoustic velocity in the bottom deposits was found to be smaller than that in the water at the corresponding depth. This confirms the observations of Press and Ewing in the Atlantic Ocean. The discrepancies between the results of determination of the acoustic velocity in laboratories and those at the ocean bottom were not over 5%. On the whole Neprochnov and Udintsev recommend the data obtained on the sea bottom as representing the true physical properties of the deposits.--S.T. Vesslow-sky (courtesy Geophysical Abstracts 180-376).

2-3404. Diment, W.H., Samuel W. Stewart, and J.C. Roller. MAXIMUM GROUND ACCELERATIONS CAUSED BY NUCLEAR EXPLOSIONS AT DISTANCES OF 5 TO 300 KILOMETERS (In: U.S. Geological Survey. Geological Survey Research 1960: Its Prof. Paper 400-B, p. B160-B161, 1960) 6 refs.

Studies of maximum ground accelerations caused by underground explosions in bedded tuff yield the following empirical scaling relation: Maximum acceleration (in units of gravity) is equal to approximately 0.6 times the 0.8 power of the yield (in kilotons) divided by the second power of the distance (in kilometers). Explosions in air at heights of 500 and

750 ft. cause maximum accelerations roughly 0.1 as large as those in tuff.--Auth.

2-3405. McKeown, Francis A., and Dayton D. Dickey. SOME RELATIONS BETWEEN GEOLOGY AND EFFECTS OF UNDERGROUND NUCLEAR EXPLOSIONS AT NEVADA TEST SITE, NYE COUNTY, NEVADA (In: U.S. Geological Survey. Geological Survey Research 1960: Its Prof. Paper 400-B, p. B415-B418, 4 maps, 2 diag., 1960) ref.

The effects of stress waves produced by the Logan and Blanca explosions on rock exposed in tunnels appear to be controlled by 1) the direction of propagation of the waves through rocks of different composition and physical properties, and 2) the angles of intersection between the direction of propagation and fractures in the rocks.--Auth.

2-3406. Bukhteev, V.G., and T.A. Andreev. ON THE EXCITATION OF STORM MICROSEISMS: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1959, no. 10, p. 1072-1074, chart, graphs, table, pub. Aug. 1960, 2 refs.

The results of analysis of microseismic records of the Far Eastern region seismic stations for the years 1954-1957 are presented. A characteristic of these seismograms is a regular change of the period of the microseismic waves parallel with development of storms. As a rule a storm begins with waves of relatively short periods; subsequently, the periods become longer with the growing amplitudes. As the storm dies out, the periods of waves remain almost constant. Several seismograms from 2 stations (Petropavlovsk, Vladivostok, and Kurilsk) are given in the article. The changes in amplitude and in frequency are interpreted as an effect of the natural frequency of vibration of the upper stratum of the crust. It was also found that the period of the microseisms varies with the seasons of the year. Special features can be observed on the seismograms of the Uglegor'sk station situated on the Tartar strait. This narrow branch of water between the Asiatic continent and Sakhalin Island makes it impossible for sea waves of longer periods and corresponding height to develop; consequently, microseisms of especially short periods are recorded.--S.T. Vesselowsky (courtesy Geophysical Abstracts 181-404).

2-3407. Tabulevich, V.N. THE NATURE OF MICROSEISMS IN THE CASPIAN BASIN: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1959, no. 11, p. 1189-1192, 5 figs. incl. 2 maps, table, pub. Aug. 1960, 2 refs.

A report on investigations of microseisms occurring within the basin of the Caspian Sea. The behavior of 96 local Caspian cyclones during the year 1956 and the effect of their coincidence with atmospheric cold fronts was studied. In 70 cases the same pattern of the variation of atmospheric conditions has led to the production of local microseisms. It is concluded that the microseisms of the Caspian basin reflect local atmospheric conditions, and the intensity of microseisms increases when a cyclone coincides with an atmospheric cold front. The source of the most intensive microseisms appears to be the western portion of the Derbent gulf and the sea near Derbent, because the meeting of atmospheric fronts with cyclones occurs here. A combination of these meteorologic conditions often appears on the NE slopes of the Caucasus.--S.T. Vesselowsky (courtesy

Geophysical Abstracts 180-322).

2-3408. Pallister, Alfred E. THE PREPARATION OF SEISMIC DEPTH MAPS IN OIL EXPLORATION: Alberta Soc. Petroleum Geologists, Jour., v. 8, no. 9, p. 235-246, 8 maps, sec., diag., Sept. 1960, 4 refs.

Sufficient subsurface geologic and seismic velocity control are now available in western Canada to warrant the preparation of depth maps from seismic reflection results. The need for this refinement is realized from the knowledge that misleading results sometimes are portrayed by seismic maps measured in reflection time due to lateral velocity changes within a prospect.

The specific factors contributing to these velocity variations are examined by referring to an area of concentrated geologic and velocity control. Seismic reflection times to several key horizons were calculated at each well in the Innisfail field and environs, using known geologic intervals together with their known velocities. The resulting reflection times were contoured as seismic reflection-time maps, to produce maps similar to those resulting from an actual seismic survey. The seismic time maps thus prepared showed the combined influence of 3 components: 1) the velocity gradient across the area, 2) differential erosion on the Paleozoic surface, and 3) actual structure of the reflecting horizon mapped.

In order to prepare useful maps from seismic surveys the first 2 of these influences must be removed. From the knowledge gained from this simulation of seismic time maps from known velocities and known geology, a method of depth conversion of seismic reflection data is suggested. This method utilizes a regional geologic structure map of a shallow formation on the basis that the major scene of velocity gradient is in the interval between this formation and the surface. Deeper maps can be prepared by adding thickness intervals to this regional map, with these intervals being calculated in a series of steps determined by velocity interfaces and recorded reflection times.

As an illustration of the effectiveness of this depth conversion method, the Innisfail field is once again considered, but this time on the basis of a minimum amount of well control. Using the seismic reflection times calculated at each well, together with a regional Blairmore geologic map, seismic depth maps were prepared. A comparison of these seismic depth maps with seismic time maps illustrates that the application of some elementary geologic structural knowledge, together with a restricted amount of velocity data, can result in the preparation of seismic depth maps of value to oil exploration.--Auth.

2-3409. Peselnick, Louis, and William F. Outerbridge. INTERNAL FRICTION AND RIGIDITY MODULUS OF SOLENHOFEN LIMESTONE OVER A WIDE FREQUENCY RANGE (In: U.S. Geological Survey. Geological Survey Research 1960: Its Prof. Paper 400-B, p. B395-B396, 2 diag., 1960) 3 refs.

The internal friction and rigidity modulus for Solenhofen limestone was measured at 3.59 cycles per second (c. p. s.) using a torsion pendulum. A comparison with high frequency data shows that the elastic constant is the same at high and low frequencies and that the internal friction is about 3 times lower than that obtained by linearly extrapolating the high frequency data to 3.59 c. p. s.--Auth.

2-3410. Keller, George V. PHYSICAL PROPERTIES OF TUFFS OF THE OAK SPRING FORMATION, NEVADA (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B396-B400, 4 logs, 2 diag., 3 tables, 1960) 5 refs.

In the northwestern corner of the U.S. Atomic Energy Commission's Nevada Test Site, tuffs of the Oak Spring formation of Tertiary age are about 2,000 ft. thick. All are rhyolitic to quartz latitic in composition. In the natural state, the rocks are almost completely saturated with water. The average porosity is about 35%; the bulk density about 1.9 g/cm³; the compressional velocity between 5,000 and 10,000 f. p. s., and the compressive strength between 2,000 and 5,000 p. s. i.--Auth.

2-3411. Vinogradov, S.D. ON THE DISTRIBUTION OF THE NUMBER OF FRACTURES IN DEPENDENCE ON THE ENERGY LIBERATED BY THE DESTRUCTION OF ROCKS: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1959, no. 12, p. 1292-1293, 2 graphs, pub. Aug. 1960, 7 refs.

An analysis of rupture in rocks in the laboratory and field due to unilateral compression is reported. The elastic impulses generated during the rupture process in coal, granite, and diabase were recorded by a piezoelectric device on a magnetic tape, and from it by an oscillograph onto a photographic film. The purpose of the study was to establish whether the correlation between the number of earthquakes and their energies established by Gutenberg and Richter holds true for earthquakes only, or whether such a correlation is true for any breakdown of rocks regardless of the scale of the phenomenon. It was found that the statistical correlation between the number of ruptures and the amount of energy liberated by them is the same both for earthquakes and for tests of rock samples in the laboratory.--A.J. Shneiderov (courtesy Geophysical Abstracts 181-484).

2-3412. Abb, E.A., and others. SOME PROBLEMS IN THE CONSTRUCTION OF A BOREHOLE NEUTRON GENERATOR. Translated by Henry Faul: Internat. Geology Rev., v. 2, no. 10, p. 882-887, 4 diag., 2 graphs, Oct. 1960, 5 refs.

In designing neutron generators which will be put down boreholes, the usual vacuum techniques do not apply. Progress is reported in the development of an ion source that can operate effectively under conditions such that the pumping of gas is kept to a minimum and in the design of special pumping systems specifically for borehole conditions.--M. Russell.

2-3413. Martinez, Prudencio. METHOD OF GRINDING CESIUM IODIDE CRYSTALS (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B507-B508, 3 illus., 1960)

For alpha scintillation counting, very thin crystals of soft materials such as cesium iodide are often required. A method for grinding and polishing unmounted single crystals as thin as 75 microns and as much as half an inch in diameter is described.--Auth.

2-3414. Bulashevich, Yu. P., and R.K. Khayritdinov. ON THE THEORY OF EMANATION DIFFUSION IN POROUS MEDIA: Akad. Nauk SSSR, Izvestiya,

Geophysics Ser., in translation, 1959, no. 12, p. 1252-1255, graph, pub. Aug. 1960, 10 refs.

The generalized equation for radioactive diffusion in the presence of convection is analyzed. It was found that the usual equation for radioactive diffusion, $\Delta c - (\lambda c/D) = -Q/D$, cannot be applied under the boundary conditions $c_1 = c_2$ and $D_1 (\partial c_1 / \partial n) = D_2 (\partial c_2 / \partial n)$, but must be replaced by the corrected formula, $\Delta c - (\lambda c \eta / D) = 0$, where c is the pore concentration of emanation, D is the diffusion coefficient, Q is the rate of emanation in the pores per unit volume, λ is the decay constant, and η is porosity. Errors were found in previously determined values of diffusion coefficients, and the method for elimination is shown.--A.J. Shneiderov (courtesy Geophysical Abstracts 181-408).

2-3415. Filippov, E.M. (Fillippov). THE SPECTRUM OF SCATTERED GAMMA RADIATION IN ROCK STRATA OF VARIOUS MINERALOGICAL COMPOSITIONS. Translated by Henry Faul: Internat. Geology Rev., v. 2, no. 10, p. 874-881, 8 graphs, 2 tables, Oct. 1960, 23 refs.

Curves of the dispersion of gamma-radiation in rocks are drawn on the basis of measurements on rocks of various compositions and density. The energy spectrum of scattered gamma-radiation shows an accumulation of softer rays. A decrease of the effective atomic number and of the density of the substance produces a shifting of the spectrum toward smaller energies of scattered radiation and vice versa. An increase in density of the substance and in its effective atomic number causes a decrease in intensity of gamma-radiation. In addition to soft rays the spectrum shows a considerable portion of rays with energies ranging from 1.25 to 0.212 Mev. Housings of gamma-gamma logging instruments should therefore be of materials which do not block the softer gamma-rays (for instance duraluminum walls less than 1 cm. thick or steel less than 0.6 cm. thick). In such cases all gamma-rays with energies down to 0.03 Mev. will be registered. The use of the differential gamma-spectrometers permits the distinguishing of rocks and ores according to their mineralogical content.--S.T. Vesselowsky (courtesy Geophysical Abstracts, 178-346).

2-3416. Brown, R.J.S., and Bernard W. Gamson. NUCLEAR MAGNETISM LOGGING: Jour. Petroleum Technology, v. 12, no. 8, p. 201-209, 11 figs., Aug. 1960, 11 refs.; also pub. as: AIME, Petroleum Transactions, v. 219, T.P. 8124, 1960.

A new logging method has been developed, based on measurement of the nuclear magnetism of formation fluids. The nuclear magnetism log (NML) is the only log that responds solely to formation fluids. It operates equally well in both oil-base and water-base muds and in empty holes, and can be used in all kinds of formations except strongly magnetic ones. Two separate NML measurements can be made, one of which provides a continuous formation fluid curve. This fluid curve is called the free fluid log (FFL) and is believed to indicate a minimum effective porosity in most formations. The FFL not only delineates fluid-containing zones, but provides an excellent correlation curve that can be obtained under conditions where conventional correlation logs are ineffective. Preliminary tests indicate that the second kind of NML measurement may help distinguish oil and water zones and provide information concerning permeability and wettability. (The FFL itself

appears to provide some information on permeability.) The second kind of NML measurement requires stopping the logging tool for a short time opposite a zone of interest and taking more extensive NML data that can be displayed as nuclear magnetic relaxation curves. In some instances, oil and water saturations for the region immediately adjacent to the borehole can be read from these relaxation curves.--Auth.

2-3417. Hull, Paul, and John E. Coolidge. **FIELD EXAMPLES OF NUCLEAR MAGNETISM LOGGING:** Jour. Petroleum Technology, v. 12, no. 8, p. 14-22, 18 figs., 2 tables, Aug. 1960, ref.

Field examples are presented from various operating areas which demonstrate the capability of the nuclear magnetism log to operate under most drilling and formation conditions. On the basis of these examples, it is shown that 1) the free fluid index of nuclear magnetism logging provides a superior means of reservoir rock definition, yields a measure of formation permeability and productivity, and is an excellent correlation tool, and 2) hydrocarbon and water can be differentiated with good reliability. Operational factors are discussed along with methods of interpretation of original data.--Auth.

2-3418. Guillou, Robert B., and Robert G. Schmidt. **CORRELATION OF AERORADIOACTIVITY DATA AND AREAL GEOLOGY** (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B119-B121, 2 maps, profiles, 1960) 2 refs.

Aeroradioactivity surveying can be used as a geological mapping tool to indicate areal geologic patterns and determine lithologic continuity between outcrops in areas of residual soil. Contacts between Triassic sedimentary rock and diabase near Bealeton, Virginia, and between slate and granite near Augusta, Georgia, are clearly indicated on aeroradioactivity profiles.--Auth.

2-3419. Tanner, Allan B. **USEFULNESS OF THE EMANATION METHOD IN GEOLOGIC EXPLORATION** (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B111-B112, 1960) 3 refs.

Most emanation anomalies are probably produced by migration of Ra, rather than Rn. For Rn anomalies the maximum detectable depth is about 30 ft. if the overburden is dry and coarse, and much less if it is moist or clayey.--Auth.

2-3420. Timofeev, A.N. **ON THE THEORY OF GAMMA-PROSPECTING:** Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1959, no. 12, p. 1310-1312, sec., 2 graphs, pub. Aug. 1960, 4 refs.

Rn emanating from a U deposit overlain by porous nonradioactive material can move by diffusion and convection toward the surface and form a Rn halo far above the deposit. This may cause a large increase in the intensity of the gamma field and lead to an incorrect interpretation of the U deposit. A mathematical analysis of diffusion and convection of Rn under such conditions is carried out and a formula derived for the variation of gamma radiation anticipated under such conditions.--A.J. Shneiderov (courtesy Geophysical Abstracts 181-432).

2-3421. Nedostup, G.A., and others. **USE OF DIFFERENTIAL GAMMA SPECTROMETRY IN PETROLEUM GEOLOGY.** Translated by Henry Faul: Internat. Geology Rev., v. 2, no. 10, p. 867-873, diag., 2 graphs, log, Oct. 1960, 15 refs.

Spectral analysis of gamma radiation arising from entrapment of neutrons by the nuclei of elements in rocks is one of the most favorable areas for development of radiometry of wells. The presence of sharp maxima in the spectra of the principal rock-forming elements (Si, Ca, H, Cl, and others) presents the possibility not only of a qualitative but also of a quantitative estimate of their content in the rocks. Laboratory investigations were carried out to evaluate this method. A 1-m. by 1-m. by 1.3-m. model was filled with sand, which was first saturated with fresh water and then with water comparable to formation water. The results were presented on a graph. The curves of a secondary gamma radiation for both water types have peaks characteristic of H, Si, and Cl. This method appears to be particularly useful for determination of the composition of the liquid in reservoir rocks.

A schematic diagram of the borehole instrument is given, and the function of the various components is described. The instrument was tested in the Tuymazy oil field. The secondary gamma spectra of water-bearing sand, oil-bearing sand, and of cement-filled caves were measured. The results agree essentially with those obtained with the model. The potential of this method is estimated as very high, particularly for determination of the nature of the fluids in the rocks.--J.W. Clarke (courtesy Geophysical Abstracts, 180-336).

2-3422. Williams, Milton. **APPLICATIONS OF NUCLEAR SCIENCE IN PETROLEUM PRODUCTION:** Jour. Petroleum Technology, v. 12, no. 8, p. 11-13, Aug. 1960, 26 refs.

Reviews contributions of nuclear science to geochronology and to well logging, discusses use of radioactive tracers in well completion, well testing and repairs, and briefly mentions possible applications for utilizing energy released by nuclear explosions in petroleum production.--Jour. Petroleum Technology, p. 3.

2-3423. Bunker, Carl M., W.H. Diment, and Verl R. Wilmarth. **DISTRIBUTION OF GAMMA RADIOACTIVITY, RADIOACTIVE GLASS, AND TEMPERATURE SURROUNDING THE SITE OF THE RAINIER UNDERGROUND NUCLEAR EXPLOSION, NEVADA** (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B151-B155, map, sec., diag., logs, 1960) 7 refs.

Radiometric measurements indicate that most of the gamma radioactivity produced by the Rainier underground nuclear explosion is contained in glass formed by the explosion. Maxima of radioactivity, glass concentration, and temperature occur in a bowl-shaped zone below the explosion point. One year after the explosion, more than half of the energy of the explosion remained in the form of heat around the explosion point.--Auth.

2-3424. Somerton, W.H., and G.D. Boozar. **THERMAL CHARACTERISTICS OF POROUS ROCKS AT ELEVATED TEMPERATURES:** Jour. Petroleum Technology, v. 12, no. 6, p. 77-81, 6 graphs, 2 tables, June 1960, 6 refs.

Thermal diffusivities of some typical sedimentary rocks have been measured by a rapid unsteady-state technique. Thermal data including diffusivity and conductivity are presented for the temperature range of 200° to 1,800°F.

Diffusivities calculated from steady-state conductivity measurements compared favorably with unsteady-state data at the lower temperatures. Unsteady-state data are less reliable at higher temperatures; reported values may be as much as 20% high at temperatures in excess of 1,500°F. This is caused partly by the simplified method used in calculating diffusivity from experimental data and partly by the many thermal reactions which occur at the higher temperatures.

The marked decrease in thermal diffusivity and conductivity at elevated temperatures indicates the importance of considering the temperature dependence of thermal properties in subsurface heat-transfer calculations. Knowledge of the effects of liquid saturation, overburden and pore pressures, and heats of reaction of reservoir materials will be required before complete subsurface thermal analyses may be made.--Auth.

2-3425. Lyubimova, E.A. ON THE TEMPERATURE GRADIENT IN THE UPPER LAYERS OF THE EARTH AND ON THE POSSIBILITY OF AN EXPLANATION OF THE LOW-VELOCITY LAYERS: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1959, no. 12, p. 1300-1301, 2 graphs, pub. Aug. 1960, 12 refs.

An attempt is made to explain the low-velocity layer at 100 km. depth without resort to special hypothesis of a different physical state of the layer. Considering the upper mantle to consist of 3 layers (granite, basalt, and peridotite or dunite) the following values were found for dT/dx : 6°C., 13°C., 16°C., 18°C., 19°C., 9°C., and 4°C. per km. for the depths of 40, 50, 60, 80, 100, 150, and 200 km. respectively. Consequently, the change in the temperature gradient due to a decrease of thermal conductivity in layers 50-200 km. deep is capable of explaining the lower seismic velocities in this interval. Similar considerations of the oceanic crust lead to the conclusion that a layer of meteoritic composition under the Mohorovičić discontinuity (40 km.) is more probable than one of eclogite.--A.J. Shneiderov (courtesy Geophysical Abstracts 181-318).

2-3426. Bernstein, V.A. THE STRESS AT THE BOUNDARY BETWEEN THE MANTLE AND THE EARTH'S CRUST GENERATED BY CONVECTION IN THE MANTLE: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1959, no. 9, p. 920-928, diag., table, pub. July 1960, 20 refs.

We consider the steady convection in the spherical layer of thickness 400-450 km., forming the upper part of the mantle, which occurs in the presence of a stable temperature gradient at a constant depth. Formulas are obtained for the components of the stress at the boundary between the mantle and the earth's crust. The temperature distribution used

for the calculations is that obtained as an approximate solution of the problem of finding the earth's temperature by a consideration of the variation in the content of radioactive elements in the continental and the oceanic crust. This yields a tangential stress component of the order of $\sim 10^6$ dyne/cm.².--Auth.

2-3427. Zharkov, V.N. THERMODYNAMICS OF THE EARTH'S MANTLE: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1959, no. 9, p. 1005-1009, 4 graphs, 3 tables, pub. July 1960, 10 refs.

It is generally assumed that the earth's mantle is solid and is composed of silicates. The independent thermodynamic parameters necessary for description of its mass are its thermal expansion coefficient, specific heat, density, coefficients of the adiabatic and isothermic compressibilities, and others. Zharkov in his studies on silicates introduces, in addition to natural acoustic frequencies, the optical frequencies, following in this respect Einstein's model of a solid body. For the distribution of density in the mantle the A-theory of Bullen is assumed, and a number of physical properties such as temperature and density are computed; these values are then compared with the generally assumed characteristics of the mantle. Variations of these values as computed by Zharkov for different depth are shown on several graphs. It is concluded that the Bullen hypothesis as to variation of temperature and pressure cannot be accepted if the mantle is homogeneous; rather, it must undergo a change in chemical composition at a certain depth.--S.T. Vesselowsky (courtesy Geophysical Abstracts 181-319).

2-3428. Diment, W.H., D.L. Healey, and J.C. Roller. GRAVITY AND SEISMIC EXPLORATION AT THE NEVADA TEST SITE (In: U.S. Geological Survey. Geological Survey Research 1960: Its Prof. Paper 400-B, p. B156-B160, map, 4 graphs, table, 1960) 7 refs.

A gravity map and seismic-refraction profiles illustrate the use of geophysical techniques in determining the configuration of the surface of pre-Tertiary rocks, buried as much as several thousand feet beneath tuff and alluvium, in a basin-and-range environment.--Auth.

2-3429. Andreasen, Gordon E., Martin F. Kane, and Isidore Zietz. REGIONAL GEOLOGICAL INTERPRETATION OF AEROMAGNETIC AND GRAVITY DATA FOR THE ROWE-MORA AREA, NEW MEXICO (In: U.S. Geological Survey. Geological Survey Research 1960: Its Prof. Paper 400-B, p. B238-B239, map, 1960) 2 refs.

A regional contour map of the Precambrian surface for part of northeastern New Mexico has been prepared from drill hole, aeromagnetic, and gravity data. The principal features of the map are the Sierra Grande arch, a basement highland, and the Las Vegas basin, a broad depression which offers prospects for petroleum exploration.--Auth.

7. GEOCHEMISTRY

See also: Geologic Maps 2-3149, 2-3150; Stratigraphy 2-3316; Geophysics 2-3425, 2-3427; Igneous and Metamorphic Petrology 2-3497; Mineral Deposits 2-3532 through 2-3543, 2-3548, 2-3550.

2-3430. Annell, C. S., and Armin W. Helz. **PETROCHEMICAL ANALYSIS USING CONTROLLED ATMOSPHERES WITH A SIMPLE GAS ET** (In: U.S. Geological Survey. Geological Survey Research 1960; Its: Prof. Paper 400-B, p. B497-B499, 2 illus., 1960) 4 refs.

A simply constructed open top gas jet holds a 1/4-in. graphite sample electrode. A 4:1 Ar-O mixture flowing upward around the electrodes at 20 cu. ft. per hour effectively suppresses cyanogen band emission during the arcing. Sensitive spectral lines in the 3,500-4,200 Å wave length region can be used for analyses.--Auth.

2-3431. Grimaldi, Frank S. **DILUTION-ADDITION METHOD FOR FLAME SPECTROPHOTOMETRY** (In: U.S. Geological Survey. Geological Survey Research 1960; Its: Prof. Paper 400-B, p. B494-B495, diag., 2 tables, 1960) ref.

The method requires no prior knowledge of the chemical composition of the sample. Matrix effects are largely overcome by sufficient dilution of the sample, and residual matrix effects are corrected for by an addition technique. The net emissions define the upper region of a curve characteristic of a given sample matrix, the original concentration of the test element being determined by extrapolation.--Auth.

2-3432. Cuttitta, Frank, and Jesse J. Warr. **PREPARATION OF LEAD IODIDE FOR MASS SPECTROMETRY** (In: U.S. Geological Survey. Geological Survey Research 1960; Its: Prof. Paper 400-B, p. B487-B488, 1960) 4 refs.

Samples undergoing geochronological studies require the separation of Pb, its purification, and conversion to iodide. Procedures to perform these operations to provide material suitable for a mass spectrometric analysis of isotopic composition are described. Characteristic data for PbI₂ are given.--Auth.

2-3433. Stevens, Rollin E., and others. **COMBINATION OF GRAVIMETRIC AND SPECTROGRAPHIC METHODS IN THE ANALYSIS OF SILICATES** (In: U.S. Geological Survey. Geological Survey Research 1960; Its: Prof. Paper 400-B, p. B499-B501, 1960) 4 refs.

This method of analysis is proposed as a means of avoiding errors and of making chemical analyses of silicate minerals and rocks more accurate and complete. Special wet chemical separations and spectrographic analysis of separates are briefly outlined.--Auth.

2-3434. Pommer, Alfred M. **SODIUM-SENSITIVE GLASS ELECTRODES IN CLAY TITRATIONS** (In: U.S. Geological Survey. Geological Survey Research 1960; Its: Prof. Paper 400-B, p. B502-B504, diag., table, 1960) 15 refs.

Na-sensitive glass electrodes have recently become commercially available. Although they are best used at constant pH values only, they have been used successfully in clay titration studies where constant pH values could not be maintained. A discon-

tinuous Na titration of a H montmorillonite gave results consistent with its pH titration.--Auth.

2-3435. Schnepfe, Marian M. **CATION EXCHANGE WITH VERMICULITE** (In: U.S. Geological Survey. Geological Survey Research 1960; Its: Prof. Paper 400-B, p. B161-B163, 3 tables, 1960) 3 refs.

The cation exchange properties of 8 selected vermiculite samples from the United States and South African sources were investigated to evaluate this mineral as a scavenger of Cs from nuclear wastes. Na ions were used as a measure of the exchange capacity of vermiculite for Cs. Vermiculites were found to be quite variable in their rate of exchange; the exchange values ranged from 120 to 173 milliequivalents per 100 g. in the samples tested.--Auth.

2-3436. May, Irving. **PREPARATION OF STABLE GELATIN-MONTMORILLONITE CLAY EXTRUSIONS** (In: U.S. Geological Survey. Geological Survey Research 1960; Its: Prof. Paper 400-B, p. B163-B164, 1960) 2 refs.

Fixation of radioactive waste elements in stable solids would make their long-term storage safer and possibly cheaper. A gelatin-montmorillonite clay mixture is described which can be extruded as a continuous filament. The extruded material, after being dried and broken into short lengths, is very stable and is therefore a better base-exchange medium than the materials previously used.--Auth.

2-3437. Cuttitta, Frank. **DETERMINATION OF SMALL QUANTITIES OF OXYGEN ADSORBED ON ANATASE** (In: U.S. Geological Survey. Geological Survey Research 1960; Its: Prof. Paper 400-B, p. B488-B490, diag., 1960) 5 refs.

Measurements show that the O adsorbed on powdered anatase is about 0.35 to 0.40%, which is about the same amount as theoretical calculations show is necessary to account for observed anomalies in the magnetic susceptibility with variations in temperature. The procedure for measuring the O utilizes its reaction with Cu moistened with ammonia-ammonium chloride solution, the intensity of the blue cupriammine complex being a measure of the O content.--Auth.

2-3438. Jackson, Everett D. **X-RAY DETERMINATIVE CURVE FOR NATURAL OLIVINE OF COMPOSITION Fo₈₀₋₉₀** (In: U.S. Geological Survey. Geological Survey Research 1960; Its: Prof. Paper 400-B, p. B432-B434, diag., table, 1960) 3 refs.

A refined X-ray diffraction method of estimating olivine compositions in a limited part of the forsterite-fayalite series provides an accuracy greater than ± 0.5% Fo.--Auth.

2-3439. Kinser, Charles A. **CHANGES IN THERMOGRAVIMETRIC CURVES OF CALCIUM SULFATE DIHYDRATE WITH VARIATIONS IN THE HEATING RATE** (In: U.S. Geological Survey. Geological Survey Research 1960; Its: Prof. Paper 400-B, p. B348-B349, 3 diags., 1960) 2 refs.

Thermogravimetric curves of calcium sulfate dihydrate disclose a transition at the hemihydrate composition when the temperature is raised at the rate of 0.5 to 1 degree per minute, but not when the temperature is raised at the rate of 4 degrees per minute.--Auth.

2-3440. Huffman, Claude, Jr. WATER-SOLUBLE BORON IN SAMPLE CONTAINERS (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B493-B494, 1960) 2 refs.

B, leached with boiling water from a series of cardboard cartons used as sample containers at the Denver laboratory, was determined spectrophotometrically using the carminic acid procedure. The results ranged from 90 to 550 p.p.m. water-soluble B. B contamination of samples prepared for analysis or stored in such paper containers may well explain high and erratic data for B determined spectrographically on samples in the Pierre shale study.--Auth.

2-3441. Carroll, Dorothy, and Alfred M. Pommer. ACIDIC PROPERTIES OF FITHIAN "ILLITE" (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B434-B436, diag., table, 1960) 4 refs.

The reaction of Fithian "illite" in the H-form with NaOH is slow compared to that of montmorillonite. The pH values obtained from discontinuous titration of the clay with NaOH change with time. After 75 days of standing, the pH values obtained, plotted semi-logarithmically against concentration of NaOH, gave a curve that resembles the one given by montmorillonite and that shows the presence of 2 clay acids in the "illite."--Auth.

2-3442. Carroll, Dorothy. CARBON DIOXIDE AND ALUMINA IN THE POTENTIOMETRIC TITRATION OF H-MONTMORILLONITE (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B436-B438, diag., 2 tables, 1960) 8 refs.

Reaction of CO_2 with NaOH during potentiometric titration of H-montmorillonite causes a lowering of pH values in dilute solutions. The alumina found in the filtrates from a discontinuous titration of H-montmorillonite with NaOH is due, not to attack on the octahedral layer by acid during preparation of the sample, but to reaction of the mineral with NaOH.--Auth.

2-3443. Rader, Lewis F., and others. DETERMINATION OF ZINC IN BASALTS AND OTHER ROCKS (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B477-B480, diag., 2 tables, 1960) 11 refs.

A method is outlined for the precise determination of microconcentration of Zn in rocks of several types. Standard deviations, calculated from replicate determinations, show the precision of the method to be 6 p.p.m. Zn for the basalt and related samples in the range up to 200 p.p.m. Zn. A correlation plot of Zn to total Fe in basalts and related rocks shows a narrow band having approximately the width of 2 standard deviations of the Zn determination.--Auth.

2-3444. Warr, Jesse J., and Frank Cuttitta. THE DETERMINATION OF LEAD IN IRON-BEARING MATERIALS (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B483-B484, 1960) 6 refs.

The Pb-dithizone mixed-color system has been applied to the determination of Pb in amounts greater than 10 p.p.m. in Fe-bearing materials. The interference of V, Fe, Sn, Cu, Bi, and Tl in the dithizone

method is eliminated by an extraction of these ions as cupferrates or carbamates or both in chloroform.--Auth.

2-3445. Cuttitta, Frank, and Jesse J. Warr. DETERMINATION OF LEAD IN PYRITES (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B485-B486, 1960) ref.

The Pb-dithizone mixed-color system has been applied to the determination of trace amounts of Pb in pyrite. A method is given for the isolation and purification of the pyritic Pb and its conversion to the PbI_2 used in mass spectrometry.--Auth.

2-3446. Cuttitta, Frank, and Jesse J. Warr. DETERMINATION OF LEAD IN ZIRCON WITH DITHIZONE (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B486-B487, table, 1960) 4 refs.

An analytical procedure based on the Pb-dithizone mixed-color system has been applied to the determination of amounts greater than 25 p.p.m. of Pb in zircon. A standard deviation of 10% or less was calculated from replicate chemical analyses.--Auth.

2-3447. Dinnin, Joseph I. DETERMINATION OF TOTAL IRON IN CHROMITE AND CHROME ORE (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B476-B477, table, 1960) 3 refs.

Chromite or chrome ore is decomposed in a mixture of concentrated phosphoric and sulfuric acids at 200° to 300°C . The cooled diluted solution, containing chlorides, is passed through a Ag reductor and titrated with standard dichromate solution. No separations are necessary.--Auth.

2-3448. Shapiro, Leonard. A SPECTROPHOTOMETRIC METHOD FOR THE DETERMINATION OF FeO IN ROCKS (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B496-B497, 1960) 3 refs.

A method has been developed for the determination of FeO which avoids the use of oxidizing agents and the difficulties associated with them. The procedure is based on decomposing the sample with $\text{HF-H}_2\text{SO}_4$ in the presence of orthophenanthroline. The orthophenanthroline forms a colored complex with the ferrous Fe as it goes into solution.--Auth.

2-3449. Hoyte, Alfred F. A GAMMA-RAY ABSORPTION METHOD FOR THE DETERMINATION OF URANIUM IN ORES (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B504-B507, diag., 1960) 3 refs.

The transmission coefficients in Pb of low-energy gamma rays from U and 2 of its daughter products have been determined, and the values obtained have been used in a system of linear equations to determine the U content of several ore samples. The method seems to be reliable for samples that contain at least 0.30% U.--Auth.

2-3450. Frost, Irving C. COMPARISON OF THREE METHODS FOR THE DETERMINATION OF TOTAL AND ORGANIC CARBON IN GEOCHEMICAL STUDIES (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B508-B509, table, 1960) 4 refs.

search 1960: Its: Prof. Paper 400-B, p. B480-B483, 4 tables, 1960) 4 refs.

Three methods for the determination of total and organic C are outlined and their precisions compared. Tube-furnace combustion with gravimetric determination of carbon dioxide has the greatest precision but requires more time than the others. The gasometric method, which measures the volume of carbon dioxide evolved, is rapid and makes it possible to measure as little as 0.2% of organic C. In both the above methods the C in any carbonate minerals that may be present is determined separately and the organic C calculated as the difference from the total C. A modified combustion-titration method determines organic C directly, after removing any carbonate minerals and sulfides that may be present with acid. This method reduces the determinable quantity of organic C to about 0.03%.--Auth.

2-3451. Burns, James R. VARIATION OF ALUMINUM, SODIUM, AND MANGANESE IN COMMON ROCKS (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B164-B165, table, 1960)

Common igneous, sedimentary, and metamorphic rocks are here divided into chemically distinguishable groups, differing significantly in their content of Mn, Na, and Al. Within most groups, the common range (60 to 80% of cases observed) is one-half M (median) to 2M for Al, 1/3 to 3M for Na, and 1/5M to 5M for Mn. Medians of different groups generally differ less than the extremes within a single group.--Auth.

2-3452. Hanshaw, P.M., and Paul R. Barnett. POSSIBLE USE OF BORON, CHROMIUM, AND NICKEL CONTENT IN CORRELATING TRIASSIC IGNEOUS ROCKS IN CONNECTICUT (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B170-B172, 3 charts, 1960) 5 refs.

Three layers of extrusive rocks and several intrusive masses, all of basaltic composition and Triassic age, are megascopically similar. Quantitative spectrographic analyses, however, appear to indicate that the extrusives may contain more B than the intrusives, that the Holyoke basalt contains the least Cr and the Talcott basalt layer and the intrusives the most; and that the Holyoke basalt contains the least Ni.--Auth.

2-3453. Flanagan, Francis J., William Lee Smith, and Alexander M. Sherwood. A COMPARISON OF TWO ESTIMATES OF THE THORIUM CONTENT OF THE CONWAY GRANITE, NEW HAMPSHIRE (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B168-B169, table, 1960) 6 refs.

Estimates of the Th content of the Conway granite were obtained by subtracting the equivalents of the U and K contents from the radioactivity measured by beta-counting. The mean of these estimates is only 3% greater than the average Th content determined chemically.--Auth.

2-3454. Myers, Alfred T., John C. Hamilton, and Verl R. Wilmarth. A STUDY OF RHENIUM AND MOLYBDENUM IN URANIUM ORE FROM THE RUNGE MINE, FALL RIVER COUNTY, SOUTH DAKOTA, BY MEANS OF A SPECTROGRAPHIC AND

CONCENTRATION METHOD (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B39-B41, table, 1960) ref.

Twenty-seven samples of sedimentary rocks of Early Cretaceous age from the southern Black Hills of South Dakota were analyzed spectrographically for the rare metal Re. Six of these samples were analyzed by conventional methods and were found to contain from 0.005 to 0.01% of Re, but Re was not detected in the remaining 21 samples. A concentration technique of evaporating a water extract to dryness gave greater sensitivity for detecting Re in this suite of samples. When the dried extracts were analyzed, 10 more of the samples were found to contain Re.

The authors' results indicate that Re is associated with Mo and concentrated with amorphous uraninite, paramontroseite, and haggite in a black-striped sandstone and along fractures.--Auth.

2-3455. Overstreet, William C. METAMORPHIC GRADE AND THE ABUNDANCE OF ThO₂ IN MONAZITE (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B55-B57, table, 1960) ref.

Detrital monazite in pelitic sediments dissociates early in regional metamorphism. Metamorphic monazite then forms in rocks of all but the lowest metamorphic grades and becomes more abundant as the grade of metamorphism rises. Abundance of ThO₂ in monazite from pelitic metasediments increases from about 0.5% at the greenschist facies to about 10% at the granulite facies.--Auth.

2-3456. Bell, Kenneth G. DEPOSITION OF URANIUM IN SALT-PAN BASINS: U.S. Geol. Survey, Prof. Paper 354-G, p. 161-169, 3 tables, 1960, 20 refs.

Drainage waters carry minute quantities of U into oceans, inland seas, and lakes, and when bodies of water evaporate completely in desiccating salt-pan basins, the U must be deposited together with all other dissolved materials. The ratio of U to total evaporite sediments is approximately 1:2 x 10⁷. The distribution of U in salt-pan basin sediments is not completely known. Some organic-rich muds and phosphatic sediments deposited in desiccating basins may contain U in amounts as large as 0.0X%. U may be adsorbed on clays that are deposited with some evaporite sediments. These muds, phosphatic sediments, and clays may remove nearly all of the dissolved U from the water of some basins. Anhydrite, gypsum, halite, and K-bearing evaporite minerals probably are the least uraniferous of all rocks in the earth's crust; their U contents generally are less than 0.00001%. Within salt-pan basins where oxidizing conditions tend to prevail and no significant amounts of organic-rich muds, clays, and phosphatic sediments are deposited, highly soluble U salts remain in solution and are deposited only as the basin finally is completely desiccated. These final highly soluble evaporite sediments are not likely to be preserved because they are subject to removal by wind erosion and leaching.--Auth.

2-3457. Tourtelot, Harry A., Leonard G. Schultz, and James R. Gill. STRATIGRAPHIC VARIATIONS IN MINERALOGY AND CHEMICAL COMPOSITION OF THE PIERRE SHALE IN SOUTH DAKOTA AND ADJACENT PARTS OF NORTH DAKOTA, NEBRASKA,

WYOMING, AND MONTANA (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B447-B452, chart, 3 secs., 10 diags., 1960)

The Pierre shale [Upper Cretaceous] thickens from about 500 ft. in southern South Dakota to 3,900 ft. in E.-central Wyoming. Montmorillonite is most abundant in the upper part of the Pierre shale where the formation is thin. Organic-rich rocks contain the largest amounts of V, Cu, As, Se, Mo, and U.--Auth.

2-3458. Zubovic, Peter, Taisia M. Stadnichenko, and Nola B. Sheffey. THE ASSOCIATION OF SOME MINOR ELEMENTS WITH ORGANIC AND INORGANIC PHASES OF COAL (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B84-87, graphs, table, 1960) 2 refs.

Analysis of the ash of float and sink fractions of 16 samples of coal show the following order of abundance in the elements associated with the organic matter of the coal: $Ge > Ga > V > (Be, Ti) > B > Ni > Cr > Co > Y > Mo > Cu > Sn > Zn > La$. The elements most abundant in the organic fractions are those whose ions are small and highly charged, and they are believed to be present as metallo-organic complexes.--Auth.

2-3459. Zubovic, Peter, Taisia M. Stadnichenko, and Nola B. Sheffey. COMPARATIVE ABUNDANCE OF THE MINOR ELEMENTS IN COALS FROM DIFFERENT PARTS OF THE UNITED STATES (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B87-B88, table, 1960)

Averages are presented for 15 minor elements computed from the spectrographic analysis of more than 1,000 individual samples of coal representing 158 columnar and channel samples of beds in 3 major coal areas. The geochemical interpretation of the distribution of some of these elements is discussed.--Auth.

2-3460. Zubovic, Peter, Taisia M. Stadnichenko, and Nola B. Sheffey. RELATION OF THE MINOR ELEMENT CONTENT OF COAL TO POSSIBLE SOURCE ROCKS (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B82-B84, 2 tables, 1960) 2 refs.

The differences in the minor element content of coals from succeeding depositional periods reflect changes in the source rocks of the sediments of the Eastern Interior region.--Auth.

2-3461. White, Donald E. SUMMARY OF CHEMICAL CHARACTERISTICS OF SOME WATERS OF DEEP ORIGIN (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B452-B454, table, 1960) 3 refs.

Many waters of magmatic, connate, and possible metamorphic origin can be recognized from characteristic ratios and concentrations of critical elements and components; no single element or ratio is reliably diagnostic. The criteria are believed to be applicable to problems of ground-water hydrology and origin of ore deposits.--Auth.

2-3462. Ward, Frederick N., H.M. Nakagawa, and Charles B. Hunt. GEOCHEMICAL INVESTIGA-

TION OF MOLYBDENUM AT NEVARES SPRING IN DEATH VALLEY, CALIF. (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B454-B456, sec., 1960) ref.

Field colorimetric determinations show a 15-fold increase in Mo content of waters between the source spring and the edge of the salt pan where sulfate and carbonate precipitation occurs in the zone of maximum evaporation producing a Mo enrichment of the efflorescent salt.--Auth.

2-3463. Cuttitta, Frank, Frank E. Senftle, and E.C. Walker. PRELIMINARY TESTS OF ISOTOPIC FRACTIONATION OF COPPER ADSORBED ON QUARTZ AND SPHALERITE (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B491-B493, 1960) 10 refs.

Adsorption of ions carried by ground water on mineral grains may be a natural mechanism of isotopic fractionation. To check this possibility preliminary experiments were made to determine the isotopic fractionation of Cu due to adsorption on quartz and on sphalerite. A preferential uptake of the heavy isotope, Cu^{65} , was noted for both minerals, and the results indicate that further work should be done to substantiate these findings.--Auth.

2-3464. Russell, R.D., and R.M. Farquhar. LEAD ISOTOPES IN GEOLOGY: 243 p., maps, diags., graphs, tables, New York, Interscience Publishers, 1960, 106 refs.

This monograph is concerned with the isotopes of common Pb, and although the dating of U and Th minerals has been mentioned, this aspect of Pb isotopes has not been developed in detail. The authors have drawn mainly on their own views in preparing the text. Many of the ideas presented here have been published by the authors in a number of papers during the past 7 years, while other papers are now in press. The contents of these publications serve as a framework for this monograph. Included are a number of tables of useful functions found to be invaluable in carrying out calculations from measured Pb isotope ratios. These tables were made with the cooperation of the Computation Centre, University of Toronto. The appendix includes several hundred isotopic analyses of common Pb. Some have been obtained from the literature, while others represent Toronto analyses which, in many cases, are published here for the first time. All of the Toronto analyses have been recalculated, and in some cases the entire analyses were repeated, so that the list given supersedes any previous list of results from this laboratory.--From pref.

Chapters are as follows: introduction (isotopic abundance variations, decay of U and Th to Pb); measurement of Pb isotope ratios; age of the earth; dating galenas by means of their isotopic constitutions; anomalous Pb; case histories; extensions of the Holmes-Houtermans model; Pb-U-Th methods of age determination.

2-3465. Farley, Thomas Albert. HALF-PERIOD OF Th^{232} ; Can. Jour. Physics, v. 38, no. 8, p. 1059-1068, diag., 2 graphs, 2 tables, Aug. 1960, 17 refs.

A redetermination of the half-period of Th^{232} by ion chamber alpha particle spectroscopy has been made. It was originally undertaken to check the possibility that an error in the half-period of Th^{232} is

responsible for discrepancies in geological ages of rocks determined from Th/Pb ratios as compared with ages determined from U/Pb ratios. A gridded, pressurized, 2 pi geometry ion chamber using an Ar-methane counting gas was used as a detector for alpha particles emitted from thin layers of metallic Th evaporated onto glass plates. The counting rate under the Th²³² alpha peak was measured with a 256-channel pulse height analyzer, and corrections of about 1% were made for self-absorption and back-scatter by the glass plate and counting gas. The samples were chemically analyzed for Th content by a spectrophotometric method. The average half-period for 12 samples is $T_{1/2} = 1.41 \times 10^{10}$ years, with a standard error of 1%. The result is in substantial

agreement with the half-periods of greater uncertainty already reported in the literature, and geological age discrepancies cannot be attributed to error in the half-period of Th²³².--Auth.

2-3466. Amirkhanov, Kh. I., and others. ON THE DETERMINATION OF THE ABSOLUTE AGE OF POTASH FELDSPARS BY THE ARGON METHOD: Akad. Nauk SSSR, Izvestiya, Geol. Ser., in translation, 1958, no. 11, p. 94-96, graph, table, pub. June 1960, 4 refs.

The authors propose a method to determine the absolute age of K feldspars by the ratio of A^{40} and K^{40} in the permanent zone of a given sample.--LC.

8. MINERALOGY AND CRYSTALLOGRAPHY

See also: Geochemistry 2-3457; Sedimentary Petrology 2-3516; Mineral Deposits 2-3551, 2-3552, 2-3560, 2-3572.

2-3467. Gleason, Sterling. ULTRAVIOLET GUIDE TO MINERALS. A COMPLETE WORKING MANUAL FOR THE USE OF ULTRAVIOLET LIGHT IN LOCATING AND RECOGNIZING MINERALS, INCLUDING FIELD IDENTIFICATION CHARTS: 244 p., illus. (incl. col.), Princeton, New Jersey, D. Van Nostrand, 1960.

This book has been prepared to meet the need for more complete and accurate knowledge about all the fluorescent minerals and for more data on the use of ultraviolet in the field, the home laboratory, and the operating mine or mill. The fluorescent minerals are presented in sections planned to meet the specific needs of different groups of readers - the beginner, the collector, the more advanced. The 7 field identification charts, one for each color, enable the user to turn his UV lamp on an unknown mineral, note its fluorescence, and refer to the chart for that particular color, thus narrowing down the search. These field charts cover the common fluorescent minerals likely to be found on field trips, including the principal fluorescent ores and some gem and semi-precious stones.--From pref.

The following subjects are covered: the story of ultraviolet light and minerals; your first night out with the lamp; what you should know about fluorescence; ultraviolet field techniques; recognizing the minerals; field identification charts, fluorescent gem stones and lapidary material; rare and uncommon fluorescent colors, including charts; finer points of ultraviolet prospecting; ultraviolet in mine, mill, and laboratory; ore minerals under the lamp; radioactive minerals; fluorescent mineral tests; searching for new keys to fluorescence.

2-3468. Bragg, W.L. BRITISH ACHIEVEMENTS IN X-RAY CRYSTALLOGRAPHY: Science, v. 131, no. 3417, p. 1870-1874, 6 diags., June 24, 1960.

A short summary of the X-ray, its discovery and early history, together with a brief explanation of the mechanism in use. The author describes the basic molecular structure of inorganics, organics, alloys, biologicals, and proteins as based on the basic research being done in Britain up to the present time. This is a general survey of the scope of British basic research in this field.--B.C. Schreiber.

2-3469. Evans, Howard T., Jr. RECENT DEVELOPMENTS IN THE CRYSTAL CHEMISTRY OF

VANADIUM OXIDE MINERALS (In: U.S. Geological Survey. Geological Survey Research 1960; Its: Prof. Paper 400-B, p. B443-B446, 6 diags., table, 1960) 9 refs.

The crystal chemical properties of 3 groups of vanadium oxide minerals are briefly described. The metastable mineral doloresite is regarded as having been derived from montroseite through an intermediate phase, protodoloresite. The occurrence of 3 forms of duttonite is explained in terms of the H bonds in its crystal structure.--Auth.

2-3470. Lindberg, Marie Louise. CRYSTAL HABIT OF FRONDELITE, SAPUCAIA PEGMATITE MINE, MINAS GERAIS, BRAZIL (In: U.S. Geological Survey. Geological Survey Research 1960; Its: Prof. Paper 400-B, p. B429-B430, diag., table, 1960) 6 refs.

Minute doubly terminated crystals of frondelite, $Mn^{2+}Fe_4^{3+}(PO_4)_3(OH)_5$, occur at the Sapucaia pegmatite mine. Frondelite is orthorhombic; its crystal forms include {100}, {010}, {110}, and {101}.--Auth

2-3471. Senftle, Frank E., Arthur Thorpe, and Francis J. Flanagan. MAGNETIC SUSCEPTIBILITY AND THERMOLUMINESCENCE OF CALCITE (In: U.S. Geological Survey. Geological Survey Research 1960; Its: Prof. Paper 400-B, p. B401-B402, table, 1960) 6 refs.

Magnetic susceptibility and thermoluminescence are both the results of trapped electrons. Experiments have been performed to show the change in magnetic susceptibility due to impurity centers and F-center formation in calcite.--Auth.

2-3472. Godovikov, A. A., and V. A. Kudryakova. CERTAIN FEATURES OF SMALTITE-CHLOANTHITE OXIDATION PROCESS: Akad. Nauk SSSR, Izvestiya, Geol. Ser., in translation, 1958, no. 10, p. 28-35, 5 illus., 3 tables, pub. June 1960, 15 refs.

English translation of GeoScience Abstracts 1-712.

2-3473. Chao, Edward C. T., and William E. Davies. AUTHIGENIC RHODOCHROSITE SPHERULES FROM GARDNER CREEK, KENTUCKY (In: U.S. Geological Survey. Geological Survey Research 1960; Its: Prof. Paper 400-B, p. B446-B447, illus., 1960) 3 refs.

Reddish brown authigenic rhodochrosite spherules

0.1 mm. in diameter from sediments of Gardner Creek, Kentucky, are described. These are nearly pure rhodochrosite with $\omega = 1.815$, $\epsilon = 1.598$, $a = 4.78$ and $c = 15.82 \text{ \AA}$. They are believed to be forming today in modern sediments.--Auth.

2-3474. Meyrowitz, Robert, and Marie Louise Lindberg. SYNTHETIC BAYLEYITE (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B440-B441, diag., table, 1960) 2 refs.

This paper describes a procedure for synthesizing large amounts of bayleyite by alternate freezing and thawing, and presents crystallographic data for the synthetic mineral.--Auth.

2-3475. Vinokurov, V.M. THE MAGNETIC PROPERTIES OF WOLFRAMITE GROUP MINERALS. Translated by E.A. Alexandrov: Internat. Geology Rev., v. 2, no. 9, p. 769-771, 2 tables, Sept. 1960, 5 refs.

The study of magnetic properties of members of the wolframite group indicates that they are paramagnetic minerals. Anisotropy of magnetic susceptibility is characterized by the presence of 3 principal directions. Two of these directions coincide with the crystallographic axis. The axis of easiest magnetization makes an angle of 80° to 130° with the edge (100) and accordingly displaces the axis of difficult magnetization. The intermediary axis coincides with L^2 of the crystal.

The presence of 3 different directions of magnetic susceptibility depends on the peculiarities of internal structure of wolframites. In particular it is caused by deformation of the polyhedron $[\text{MO}_6]$. Relatively small differences of x_x , x_y and x_z from each other (in predominantly ferrous varieties) indicate evidently a comparatively insignificant deformation of $[\text{MO}_6]$ octahedra within the structure.--Auth.

2-3476. Owens, James P., and James P. Minard. SOME CHARACTERISTICS OF GLAUCONITE FROM THE COASTAL PLAIN FORMATIONS OF NEW

JERSEY (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B430-B432, 2 tables, 1960) 3 refs.

Calculated structural formulas reveal a low inter-layer ion summation for primary glauconites, whereas reworked glauconites have consistently higher summations. Typical formulas for primary and reworked glauconites are given. Primary glauconites can be detected megascopically. Accordion forms (stacked micaceous plates) are a common primary type.--Auth.

2-3477. Ploshko, V.V. ACCESSORY ORTHOLITE FROM ACTINOLITE ROCKS OF THE MALAYA LABA RIVER: Akad. Nauk SSSR, Izvestiya, Geol. Ser., in translation, 1958, no. 11, p. 96-100, illus., 3 tables, pub. June 1960, 8 refs.

A mineral of the orthite group was discovered in metasomatic streaks found in places of contact of granitoids with the albitized actinolites of the Urushten magmatic complex, in the region of the Malaya Laba river (N. Caucasus). This mineral, by its physical and chemical characteristics, slightly differs from typical orthites and approaches the clinzoisites. It is similar to the orthites from the carbonaceous veins of the same Urushten deposit, and both are of hydrothermal origin, as has been determined by G.D. Afanasev. There are no doubts of its connection with the metasomatic action of the granite magma on the rocks enclosing the intrusion.--LC.

2-3478. Eugster, Hans P., and Thomas L. Wright. SYNTHETIC HYDROUS BORON MICAS (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B441-B442, 3 tables, 1960) 8 refs.

Hydrous boron phlogopite $\text{KMg}_3\text{BSi}_3\text{O}_{10}(\text{OH})_2$, boron annite $\text{KFe}_3\text{BSi}_3\text{O}_{10}(\text{OH})_2$, and a boron-bearing muscovite $\text{KAl}_2(\text{Al,B})\text{Si}_3\text{O}_{10}(\text{OH})_2$ have been synthesized. Boron phlogopite has the following X-ray and optical data: $a = 5.32 \text{ \AA}$, $b = 9.16 \text{ \AA}$, $c = 10.29 \text{ \AA}$, $\beta = 100^\circ 10'$, $n_x = 1.546$, $n_y = 1.568$. Details of synthesis and an indexed powder pattern are given.--Auth.

9. IGNEOUS AND METAMORPHIC PETROLOGY

See also: Areal and Regional Geology 2-3158, 2-3164, 2-3168; Structural Geology 2-3232; Geochemistry 2-3433; Sedimentary Petrology 2-3512, 2-3513.

2-3479. Peck, Dallas L. CENOZOIC VOLCANISM IN THE OREGON CASCADES (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B308-B310, map, chart, table, 1960) 4 refs.

Since the late Eocene about 30,000 cu. mi. of pyroclastic rocks and flows ranging from rhyodacite to olivine basalt have been extruded from vents aligned in northward trending belts that shifted progressively eastward with time.--Auth.

2-3480. Mullineaux, D.R., and Dwight R. Crandell. LATE RECENT AGE OF MOUNT ST. HELENS VOLCANO, WASHINGTON (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B307-B308, 1960) ref.

Wood contained in a debris flow derived from the hornblende dacites and hornblende-hypersthene an-

desites of the older part of Mount St. Helens has a radiocarbon age of about 2,000 years. The modern volcano, consisting of pyroxene andesite and olivine basalt, may have been formed entirely within the last thousand years.--Auth.

2-3481. Gorshkov, G.S. CERTAIN PROBLEMS OF THEORETICAL VOLCANOLOGY: Akad. Nauk SSSR, Izvestiya, Geol. Ser., in translation, 1958, no. 11, p. 15-20, 2 figs., pub. June 1960, 10 refs.

The author's observations of the screening of transverse seismic waves lead him to the conclusion that the reservoir of molten magma beneath the Klyuchevsky volcano lies at a depth of the order of 60 km, i.e., at the boundary between the earth's crust and mantle. On the basis of observations on the form of the "seismic shadow," the author presents his ideas about the size and shape of the magmatic chamber.--Auth.

2-3482. Shilov, V.N. DATA ON MIDDLE MIOCENE VOLCANISM OF SOUTH SAKHALIN (CHEKHOV

DISTRICT): Akad. Nauk SSSR, Izvestiya, Geol. Ser., in translation, 1958, no. 12, p. 7-13, 2 maps, table, pub. July 1960, 7 refs.

One typical example of middle Miocene volcanism on southern Sakhalin is examined in this study. Occurrence, lithology, and thickness of volcanic deposits, the Chekhov suite, are described. Changes in thickness and lithology of volcanic rocks are outlined. An analysis of volcanic activity in the area shows that the Chekhov suite deposits are not an independent stratigraphic unit but are the volcanic facies of the Nevelsk suite.--Auth.

2-3483. Powers, Howard A. ALKALIC LAVA FLOW, WITH FLUIDITY OF BASALT, IN THE SNAKE RIVER PLAIN, IDAHO (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B297, table, 1960) 3 refs.

A lava flow containing over 40% normative alkali feldspar has gross physical features that characterize mobile flood basalt.--Auth.

2-3484. Powers, Howard A. A DISTINCTIVE CHEMICAL CHARACTERISTIC OF SNAKE RIVER BASALTS OF IDAHO (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B298, diag., 1960) 2 refs.

All available chemical analyses of basalts from the Snake River valley, Idaho, are lower in silica, as compared with total Fe and magnesia, than analyses of other basalts from the northwestern United States.--Auth.

2-3485. Lebedinsky, V.I., and Mo Ke-Min. LIQUEFACTION PHENOMENA IN THE KALGANSKIY COMPLEX LAVAS: Akad. Nauk SSSR, Izvestiya, Geol. Ser., in translation, 1958, no. 12, p. 51-58, 5 illus., map, sec., 3 tables, pub. July 1960, 12 refs.

The authors describe peculiar vitreous acid lavas of the Kalgan (NE. China) region, containing more or less drop-shaped brown spherulites. Microscopic study showed that these perlitic lavas were composed of microphenocrysts (sanidine and quartz), drop-shaped spherulites and a vitreous basic mass. The microphenocrysts are the earliest, and the spherulites and the vitreous mass the latest products of the solidification of the lava. The spherulites are not of a homogeneous composition but contain small quantities of ferric oxide and microphenocrysts of sanidine and quartz. Presumably they formed in the course of the lava crystallization, when the microphenocrysts were already separated. The spherulites are liparitic, sharply different from the vitreous mass which has a higher water content and a lower alkali content. This difference could be explained by the liquefaction of the lava into 2 immiscible parts. From this emulsion, separate globules of one liquid in the other were formed. During the lava flow these accumulations of globules were transformed into streaks and lenslike accumulations, and the rapid cooling of the lava maintained this division into 2 liquids in the form of the preponderant basic vitreous mass with the enclosed drop-shaped globules. Later, in the hardened rock, spherulitic decrystallization of the globules occurred and transformed them into the spherulites. The detailed characteristics of all components are given, as well as the description of similar formations in other parts of the U.S.S.R.--LC.

2-3486. Zavaritsky, V.A. THE SPILITE-KERATOPHYRE FORMATION IN THE REGION OF THE BLYAVA DEPOSIT IN THE URAL MOUNTAINS. Translated by Grahame Spragg: Internat. Geology Rev., v. 2, no. 7, p. 551-576, July 1960; no. 8, p. 645-687, Aug. 1960, 29 figs. incl. illus., map, diags., 6 tables, 167 refs.

The green volcanic rocks of the Ural mountains are attracting more attention every year, because in them are found all the Ural pyrite districts that have become world famous. Previously, when connecting the formation of pyrite deposits with different intrusions, geologists have considered the greenstones only as host rocks. The supposition was made by A.N. Zavaritsky in 1936 that pyrite deposits and their host rocks could be products of the same process. In each region it is necessary to try to determine the character of the very old volcanism on the basis of detailed petrological analyses. The present study presents the first attempt at such analyses.--From introd.

The paper consists of 3 sections. The first part deals with the geology of the spilite-keratophyre formation: general geology; the stratigraphic section and sequence of eruptions; extrusive bodies and individual rocks; pillow lava of spilites and process of their formation; clastic-volcanic deposits. In the second section the petrographic features of the same rocks are described: spilites; spilitic porphyrites and other rocks of an intermediate composition; keratophyres; clastic-volcanic rocks. The third section is devoted to the problem of the spilite-keratophyre formation: history and significance of the spilite problem; review of the main spilite formations in England, Australia, Crimea, Mugodzhir, Karelia and Kola peninsula, Scandinavian peninsula, North America; petrochemistry of spilite-keratophyre formations; albitization and the genesis of spilitic rocks; characteristics of spilite-keratophyre formations.

2-3487. Yagi, Kenzō. ALKALIC ROCKS OF THE NEMURO PENINSULA, WITH SPECIAL REFERENCE TO THEIR PILLOW LAVAS. Translated by Kinkiti Musya: Internat. Geology Rev., v. 2, no. 10, p. 912-920, illus., map, 4 tables, Oct. 1960, 19 refs.

Mafic alkaline rocks occur as lava flows, sheets or laccoliths in the Upper Cretaceous rocks in the Nemuro peninsula, Hokkaido, Japan. Crystallization differentiation owing to gravitational separation of olivine and pyroxene is observed in some sheets or laccoliths, while remarkable pillow structure is observed in some sheets or lava flows. Pillows are mostly 50 cm.-2 m. in diameter and usually ellipsoidal in shape. Difference in crystallinity and mineral composition is observed in a pillow; i.e., its central portion is holocrystalline dolerite and its margin is tachylite with very high water concentration. Origin of the pillow lavas in this district is interpreted as follows. Very fluid doleritic lava was erupted on deep ocean bottom, sometimes intruded into thick wet sediments. Quenching by water or sediments and convection currents resulted in the formation of ellipsoidal cracks in the lava flows or sheets. Under such conditions there was not much difference between lava flows and sheets. Because of its high partial pressure the water diffused into the lava along the cracks, developing high marginal water concentration, and formed individual pillows. As the increase of water content in the melt decreased its temperature of crystallization, the wetter marginal portion might have a crystallization temperature

somewhat lower than that of the dryer central portion, and consequently crystallization in a pillow proceeded from the core to the margin, forming tachylite at the last stage. Abundance of analcite or natrolite is the result of enrichment of soda in some portions by the diffusing water vapor, though spilitization, which is fairly common in pillow lavas, is absent in the present case.--Auth.

2-3488. Lebedev, A. P. PROBLEMS IN THE STUDY OF BASALTIC MAGMA: Akad. Nauk SSSR, Izvestiya, Geol. Ser., in translation, 1958, no. 12, p. 24-34, pub. July 1960, 41 refs.

The author sums up opinions and hypotheses expressed by many Soviet and foreign scientists on the nature and evolution of primary (ancestral) magma or basaltic magmata, and on the magmatic processes in different zones of the earth's crust. The origin of basaltic magma is connected with definite plutonic spheres of basaltic or peridotite composition, these spheres probably being in a hard or vitreous state of aggregation and of slightly varying chemical composition. Basaltic magma originates in the crust as a result of a periodical melting of corresponding geospheres, and can be of slightly different composition. Further evolution of the magma, penetrating in liquid state into upper levels of the crust, depends on the structural peculiarities of the given level, different for plateau, orogenic, and other zones, and on the tectonic character of this part of the crust at the moment of penetration and solidification of the magma. The most sudden changes in the magma (as differentiation or crystallization) occur in these upper levels of the crust as a result of sudden change of pressure and temperature and of the metamorphosis of the surrounding rocks into which the magma penetrates. The magma can undergo different evolutions which lead to the occurrence of alkaline, subalkaline, acid, or pegmatoid derivatives. The phenomena of assimilation have the utmost importance to the formation of different types of basaltic magma and of different rocks originating out of this magma. The process of plutonic assimilation, or contamination, must be distinguished from the process of local assimilation, or hybridism. There are also different hypabyssal intrusions of basaltic (trap) composition into the orogenic zones, the lower structural level of the platform, and into its stratified upper sheath. The metallogenic peculiarities of the basaltic magma are strictly correlated with the composition of the magma itself and of the enclosing substratum, as well as with the nature of further crystallization and differentiation of the magma.--LC.

2-3489. Burbank, Wilbur S. PRE-ORE PROPYLITIZATION, SILVERTON CALDERA, COLORADO (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B12-B13, 1960) 7 refs.

Propylitic alteration affected many cubic miles of volcanic rocks throughout and beyond the caldera. Alteration in deep, water-deficient environments probably was accomplished by pervasive penetration of rocks by gases rich in carbon dioxide.--Auth.

2-3490. Pease, Maurice H., Jr. STRUCTURAL CONTROL OF HYDROTHERMAL ALTERATION IN SOME VOLCANIC ROCKS IN PUERTO RICO (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B360-B363, 2 maps, 1960)

Hydrothermally altered rocks in the Naranjito quadrangle, Puerto Rico, are confined to shear zones that strike N. 80°W. The hydrothermal solutions entered along N. 50°E. to N. 70°E. fractures. Faults that strike N. 20°W. to N. 40°W. acted as partial barriers to westward migration of these solutions and later movement on these same faults offset the hydrothermally altered bodies.--Auth.

2-3491. Afanasev, G. D. MELANOCRATIC ROCKS IN CERTAIN REGIONS OF THE U. S. S. R.: Akad. Nauk SSSR, Izvestiya, Geol. Ser., in translation, 1958, no. 12, p. 35-50, 7 tables, pub. July 1960, 25 refs.

The author makes an attempt to generalize and also to determine more accurately existing ideas on veined melanocratic rocks associated with the granitoid intrusions usually classified as lamprophyres. According to G. Rozenbush, the lamprophyres are not an independent formation, as they exist only in the vicinity of plutonic rocks. Their other characteristic is that they are rocks of granular or porphyritic structure. The author sums up the opinions of many geologists, gives the result of the study of melanocratic rocks in various parts of the U. S. S. R., and comes to the conclusion that no well-defined solution of this problem can yet be given. Existing data on the comagmatism of lamprophyric and leucocratic veined rocks of an intrusive block permit one to assume that these 2 rocks are the differentiates of a residual magma left after the crystallization of the intrusion of quartz-dioritic-granodioritic-granitic components. The composition of residual magma is different for granitoid rock formations of different age and type.--LC.

2-3492. Kravchenko, S. M. PETROGRAPHIC FEATURES OF INTRUSIVE MASSIFS OF THE SOUTH CENTRAL CRIMEA, IN THE LIGHT OF NEW DATA: Akad. Nauk SSSR, Izvestiya, Geol. Ser., in translation, 1958, no. 12, p. 81-86, illus., map, diag., pub. July 1960, 7 refs.

Intrusive blocks of S.-central Crimea can be divided into 2 groups of different age: 1) blocks of mainly alkaline composition and of a complicated structure and 2) younger blocks of acid composition, homogeneously porphyritic, with xenoliths of rocks of the first group. The primarily intruding magma was of an alkaline composition similar to the composition of basaltic magma. In the first stage of the intrusion, processes of fractional crystallization and of assimilation of silicic acid by the ascending magma played an important part in the formation of derivatives of the first group. Later, in the second stage, an intrusion of magma from the same magma source occurred, but, as a result of evolution of this source towards the assimilation of acid plutonic material, the formation of derivatives of the second group occurred.--LC.

2-3493. Norton, James J. HUGO PEGMATITE, KEYSTONE, SOUTH DAKOTA (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B67-B70, sec., diag., table, 1960) ref.

The Hugo pegmatite, near Keystone, South Dakota, contains 7 zones and 2 replacement bodies. Its mineral and chemical composition indicates that most of it crystallized from a fluid that was essentially a magma, and that this fluid became increasingly

silicic as crystallization proceeded; the core and the replacement units, however, are especially rich in alumina and alkalis, which were probably deposited by a fluid containing H₂O and other volatiles that separated from the silicate liquid.--Auth.

2-3494. Olshansky, Ya. I., and S. A. Brusilovsky. SIMPLE LABORATORY EXPERIMENTS DEMONSTRATING INFILTRATIONAL METASOMATIC ZONATION: Akad. Nauk SSSR, Izvestiya, Geol. Ser., in translation, 1958, no. 10, p. 85-86, diag., pub. June 1960.

English translation of GeoScience Abstracts 1-720.

2-3495. Hamilton, Warren B. METAMORPHISM AND THRUST FAULTING IN THE RIGGINS QUADRANGLE, IDAHO (In: U. S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B230-B231, map, 1960)

Index minerals of zones of progressive regional metamorphism in metavolcanic rocks of the andesite-keratophyre kindred in the Riggins quadrangle are, in order of increasing metamorphism, ferroan prochlorite, aluminian prochlorite, biotite, clinozoisite, garnet, oligoclase, and andesine. Two postmetamorphic W.-directed thrust faults have an aggregate displacement of 10 mi.--Auth.

2-3496. Pavlides, Louis. STRUCTURALLY LOCALIZED METAMORPHISM OF MANGANESE DEPOSITS, AROOSTOOK COUNTY, MAINE (In: U. S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B463-B465, table, 1960)

Weakly metamorphosed sedimentary Mn deposits in the Maple-Hovey Mountain area include 1) braunite-bearing hematitic rocks and 2) siliceous carbonate rocks. Locally, in tight folds, what were originally braunite-bearing hematitic rocks have been metamorphosed into magnetite-bearing rocks without braunite, and magnetite has formed in the siliceous carbonate rocks.--Auth.

2-3497. Engel, Albert E. J., and Celeste G. Engel. MIGRATION OF ELEMENTS DURING METAMORPHISM IN THE NORTHWEST ADIRONDACK MOUNTAINS, NEW YORK (In: U. S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B465-B470, map, 4 diags., 2 graphs, table, 1960) 6 refs.

Metamorphism of basalt, graywacke, and marble at temperatures between 500° and 600°C. is accompanied by the emission of water and CO₂-rich fluids, alkali silicates, Pb, Ba, and Mn. Some of the alkali silicates may have been mobilized as granite magma, and the Pb, Ba, and Mn may be localized in part as commercially important mineral deposits.--Auth.

2-3498. Bezmertnaya, M. S., and D. I. Gorzhevsky. CORE CONTACT METAMORPHISM OF RUDNYI ALTAI POLYMETALLIC DEPOSITS: Akad. Nauk SSSR, Izvestiya, Geol. Ser., in translation, 1958, no. 10, p. 16-27, sec., 2 diags., 2 tables, pub. June 1960, 10 refs.

English translation of GeoScience Abstracts 1-717.

2-3499. Minato, Masao. ON THE AGE OF METAMORPHISM IN THE JAPANESE ISLANDS. Translated by Reiko Fusejima: Internat. Geology Rev., v. 2, no. 10, p. 901-911, 2 figs., Oct. 1960, 23 refs.

The distribution, lithology, and previously held theories on age of metamorphic activity in Japan are outlined. Precise age determination of each metamorphic complex is still uncertain. The latest was probably Miocene, the earliest either Precambrian or as late as Devonian. Miocene metamorphism affected the so-called green tuff region of the inner zone of Japan. The Hida gneiss is the result of the oldest age of metamorphism. Absolute age determination of 230 x 10⁶ years has been made of minerals in the Ryoke gneiss, although recurring metamorphism has been shown for its area. Considerable granite emplacement occurred during the Cretaceous and early Tertiary. The age of metamorphism resulting in the Sambagawa-Mikabu complexes is much in dispute but is probably older than late Triassic.--M. Russell.

2-3500. Mitich, G. B. QUARTZITE XENOLITHS AND THE SELECTIVITY OF GRANITIZATION IN THE SOUTHWESTERN ALDAN CRYSTALLINE MASSIF: Akad. Nauk SSSR, Izvestiya, Geol. Ser., in translation, 1958, no. 12, p. 77-81, map, pub. July 1960, 10 refs.

In the lower part of the metamorphosed rocks of the SW. Aldan crystalline massif (approximately 10,000 m. thick and belonging to the Iengraien series of the upper Archean), a quartzite sequence, 1,500 m. thick, can be observed. Separate layers and lenses of quartzite can also be observed in the mass of crystalline schists. On the whole, this massif is composed of: gneissic granites (74.4%), quartzites (15.7%) and crystalline schist (9.6%). The rocks of the Iengra series form separate blocks of different importance in the mass of gneissic granites. The author considers the smaller blocks as micro- and the larger as macroxenoliths. More than two-thirds of the mass of the macroxenoliths is composed of quartzites. According to the author, it indicates that the granitization of the Iengraien series of rocks occurred mainly in the mass of crystalline schists, and the feldspathization of quartzites was much less important and only on the lines of contact. The occurrence of feldspars in the quartzites can be explained in 2 ways. Though infiltrational magmatic feldspathization occurred in some places, authigenic feldspars also occur; they were subjected to an intensive collective recrystallization during the intensive metamorphism of the quartz-feldspathic sandstones. Thus, in this region infiltrational metasomatic granitization occurred rather than the phenomenon of anatexis. More active chemically crystalline schists composed of various unstable minerals succumbed to the granitization process faster than the quartzites composed basically of less active silica, more resistant to a chemical process. Granitization occurred widely and fully in heterogeneous stratigraphic layers and strata of crystalline schists and at a much lesser degree in the quartzite strata; the process of feldspathization occurred mainly here. It can be said that, as a result of selective granitization of the rocks of the Iengraien series, the quartzites represent the skeleton of the original series.--L.C.

2-3501. Schlocker, Julius. RODINGITE FROM ANGEL ISLAND, SAN FRANCISCO BAY, CALIFOR-

NIA (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B311-B312, illus., 1960) 11 refs.

The rodingite in serpentinite of Angel Island represents tectonic inclusions rather than dikes cutting the serpentinite. Some have relict textures like those of the porphyritic greenstones and tachylitic volcanics intruded by the serpentinite. Related rocks such as volcanic graywackes may also have been altered to rodingite.--Auth.

2-3502. Wallace, Robert E., Donald B. Tatlock, and Norman J. Silberling. INTRUSIVE ROCKS OF PERMIAN AND TRIASSIC AGE IN THE HUMBOLDT RANGE, NEVADA (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B291-B293, map, 1960) 5 refs.

Intrusive bodies of rhyolite porphyry and leucogranite in the Humboldt Range are genetically related to, and in part represent feeders for, extrusive rocks of the Koipato group. They were probably emplaced near the beginning of the Mesozoic era.--Auth.

2-3503. Cater, Fred W., Jr. CHILLED CONTACTS AND VOLCANIC PHENOMENA ASSOCIATED WITH THE CLOUDY PASS BATHOLITH, WASHINGTON (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B471-B473, map, 1960)

The Cloudy Pass batholith, of Tertiary age, reached an exceptionally high level in the earth's crust and in so doing developed chilled porphyritic borders and gave rise to hypabyssal porphyry plugs, intrusive breccias, and a volcanic neck.--Auth.

10. SEDIMENTARY PETROLOGY

See also: Geomorphology 2-3215; Stratigraphy 2-3271, 2-3275; Geochemistry 2-3456; Mineral Deposits 2-3548.

2-3504. Gulbrandsen, Robert A. PRECIPITATION OF SALTS FROM SOLUTION BY ETHYL ALCOHOL AS AN AID TO THE STUDY OF EVAPORITES (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B504, 1960)

Precipitation of salts by adding ethyl alcohol to saline solutions is a means of overcoming some of the difficulties encountered in evaporation experiments.--Auth.

2-3505. Nichols, Donald R. SLUMP STRUCTURES IN PLEISTOCENE LAKE SEDIMENTS, COPPER RIVER BASIN, ALASKA (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B353-B354, illus., 1960) 2 refs.

Certain small-scale overturned folds, and normal and low-angle thrust faults in finely laminated sand, silt, and clay appear to have resulted from subaqueous sliding. Earthquakes presumably accompanied extensive Quaternary volcanic activity and may have triggered the sliding.--Auth.

2-3506. McKee, Edwin D. SPATIAL RELATIONS OF FOSSILS AND BEDDED CHERTS IN THE REDWALL LIMESTONE, ARIZONA (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B461-B463, 4 illus., 1960) ref.

Beds of chert containing abundant external molds of fossils alternate with thin beds of carbonate rock in part of the Redwall limestone [Mississippian] of Grand Canyon. Sample plots of these rocks show 1) differences in the classes of fossils represented from E. to W. (nearshore to geosyncline), 2) increase in variety and abundance of fossils in the same direction, 3) greater abundance of fossils in chert than in associated carbonate rocks, and 4) that the chert developed early and prior to dolomitization.--Auth.

2-3507. Altschuler, Z.S., and E.J. Young. RESIDUAL ORIGIN OF THE "PLEISTOCENE" SAND MANTLE IN CENTRAL FLORIDA UPLANDS AND ITS BEARING ON MARINE TERRACES AND CENOZOIC UPLIFT (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B,

p. B202-B207, 2 maps, sec., 3 diags., 2 profiles, 1960) 7 refs.

The sedimentology of the quartz sands blanketing the Land Pebble phosphate field in W.-central Florida was studied in relation to the lateritic weathering that affected the underlying Pliocene phosphorite. The sand mantle in higher areas of eastern Hillsborough and western Polk counties, Florida, is shown to be principally a residual sand plain formed by lateritic weathering of Pliocene sediments rather than a succession of Pleistocene marine terraces. Deposition of the sands was influenced by contemporaneous uplift in linear belts. Uplift continued after deposition, bowing up the sediments and resulting in the prominent linear ridges of the region.--Auth.

2-3508. Zen, E-an. EARLY STAGES OF EVAPORITE DEPOSITION (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B458-B461, 5 diags., table, 1960) 6 refs.

Application of Gibbs' Phase Rule shows that unimineralic evaporite deposits could not be formed in closed basins. They could be formed, however, by fractional crystallization from an ocean current. In such a current, continued evaporation and variations in physical conditions result in different unimineralic beds rather than polyminerallc beds. Fluctuations in conditions could result in interlamination of unimineralic beds.--Auth.

2-3509. Hunt, Charles B. THE DEATH VALLEY SALT PAN, A STUDY OF EVAPORITES (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B456-B458, 3 diags., 1960)

Salts in the Death Valley salt pan are in orderly zones and layers reflecting their different solubilities. The chlorides, which are the most soluble, are in the center of the pan or at places on the surface where ground water evaporates. Sulfates surround the chloride zone, and where ground water is evaporating they form a layer beneath the chloride crust. Carbonates surround the sulfates and underlie the sulfate and chloride layers.--Auth.

2-3510. Mattson, Peter H., and Lynn Glover, 3d. STRATIGRAPHIC DISTRIBUTION OF DETRITAL

QUARTZ IN PRE-OLIGOCENE ROCKS IN SOUTH-CENTRAL PUERTO RICO (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B367-B368, table, 1960) 2 refs.

Detrital quartz in S.-central Puerto Rico is confined almost entirely to rocks of latest Cretaceous age or younger; quartz is absent from a thick sequence of older volcanic rocks. The late appearance of quartz indicates an enrichment in silica of the Late Cretaceous and Eocene(?) magmas.--Auth.

2-3511. Kopeliovich, A.V. EPIGENETIC FEATURES OF SANDSTONES OF THE MOGILEV FORMATION OF THE SOUTHWESTERN PART OF THE RUSSIAN PLATFORM AND CERTAIN PROBLEMS ASSOCIATED WITH THEM: Akad. Nauk SSSR, Izvestiya, Geol. Ser., in translation, 1958, no. 11, p. 21-33, 11 illus., pub. June 1960, 17 refs.

In the deeply submerged parts of the sedimentary mantle of the Russian platform, because of the pressure produced by the overlying sediments, clastic rocks are partially recrystallized and undergo profound textural changes accompanied by the formation of a distinctive set of secondary minerals. These transformations, which are not characteristic of the normal sedimentary rocks, occur during a definite late stage of epigenesis and are identical with the changes typical of the early stages of metamorphism. These altered rocks, therefore, may be regarded as transitional between sedimentary and metamorphic.

Inasmuch as the beds of the Mogilev formation [late Precambrian-early Paleozoic] lie within the platform and are horizontal, their alteration cannot be ascribed to deformation. The alteration occurs without any noticeable additions of material from the deeper zones of the earth and results from the regrouping of the original material of the sedimentary rocks themselves.

The presence of rocks with clear signs of regional metamorphism in the deep parts of the sedimentary mantle of the platform requires a revision of the existing idea that regional metamorphism takes place at great geosynclinal depths and that magmatic influences play a leading role in it.--Auth. summ.

2-3512. Gard, Leonard M., Jr. SUGGESTED SOURCE OF MIOCENE VOLCANIC DETRITUS FLANKING THE CENTRAL CASCADE RANGE, WASHINGTON (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B306-B307, map, 1960) 9 refs.

Magma apparently broke through to the surface during intrusion of the Snoqualmie granodiorite batholith in late Miocene time, causing explosive volcanism that gave rise to pumiceous mudflows and ash now found on both flanks of the Cascade Range. No source volcanoes, however, have yet been recognized.--Auth.

2-3513. Fraser, George D. PAHALA ASH - AN UNUSUAL DEPOSIT FROM KILAUEA VOLCANO, HAWAII (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B354-B355, map, 1960) 3 refs.

Large phreatomagmatic explosions at undifferentiated Kilauea volcano were the source for a widespread blanket of ash not duplicated elsewhere in Hawaii. Older Hawaiian volcanoes have changed chemically without producing large explosions. The largest explosions have been produced where ground water has mixed with tholeiitic magma.--Auth.

2-3514. Masursky, Harold. WELDED TUFFS IN THE NORTHERN TOiyabe RANGE, NEVADA (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B281-B283, map, table, 1960) 7 refs.

Oligocene(?) welded tuffs about 8,000 ft. thick were laid down in a fault-bounded trough, perhaps a volcano-tectonic depression. As interbedded giant boulder fanglomerates wedge out and become finer grained away from the faults, the faults probably were active during deposition of the volcanics.--Auth.

2-3515. Gibbons, Anthony B., E. Neal Hinrichs, and Theodore Botinelly. THE ROLE OF IMPERMEABLE ROCKS IN CONTROLLING ZEOLITIC ALTERATION OF TUFF (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B473-B475, 2 secs., table, 1960) 10 refs.

In a part of southern Nevada, the spatial relation of zeolitized tuff and unaltered vitric tuff of impermeable rocks, together with the irregularities of the contacts between the fresh and altered tuff, indicate that the vitric tuff was zeolitized at near-surface temperatures by mildly alkaline ground water which moved along the contacts of the impermeable rocks.--Auth.

2-3516. Kerr, Paul F., assisted by Karin E. Klink. ITEM 2. SALINE BASINS OF NORTH AND SOUTH AMERICA. A PRELIMINARY LITERATURE SUMMARY: 59 p., 22 figs. incl. maps, secs., New York, Columbia University, Dept. of Geology, 1959, approx. 200 refs.

Item 2 is intended to provide a convenient and condensed key to the most significant literature on the saline basins of the 2 American continents and intermediate islands. The purpose is to provide a progress item covering a second unit in the study of the literature of saline deposits and saline minerals. Item 1 [GeoScience Abstracts 2-2111] provided a preliminary survey of the saline deposits of the Basin and Range province of western United States. It is being revised prior to duplication in a form similar to Item 2.

The saline basins of the 2 American continents range geographically from the Canadian Arctic to Patagonia. Many are small and a number are poorly defined, but saline masses such as those which fill the Gulf Coast, Permian, Western Canada, Michigan, and Ohio-New York basins are tremendous in size.

If one considers those formed prior to the Quaternary, the American basins range in age from early Paleozoic to Tertiary, with the greatest volume of deposition in the Paleozoic. In contrast, Tertiary salt accumulation appears to have been a minor feature.

The depth of burial and the thickness of salt beds in a basin are frequently not known. Further, the thickness of beds as sometimes recorded is the column of salt penetrated in a domal structure rather than the true thickness of the salt-bearing strata. Nevertheless, salt accumulations of great thickness exist. Salt strata are believed to approach 2,500 ft. in thickness in the Paradox basin in Colorado and Utah.

The greatest concentration of salt domes is found along the borders of the Gulf of Mexico. Here domes are found both in Mexico and in the United States. Four essentially separate areas in which domes occur in abundance are found in the Texas-Louisiana-Mis-

Mississippi-Alabama basin area. Domal exposures of the Arctic are believed to be caused by salt piercement, although the actual salt has not yet been observed.

Several basins are known to be potash-bearing, and it has been estimated that the total volume of potash salts in the Western Canada basin equals the rest of the world.

The stratigraphic literature is voluminous particularly concerning the basins of the United States and Canada. In this survey references are largely limited to those revealing data relevant to saline deposition. An effort has been made to assemble references that will provide a key to the available literature for each basin. Where the information is available, outlines of the salient dimensional characteristics of each basin are given. Where figures are omitted, it is because data have not been readily available in the literature.

Illustrations selected from the literature are designed to provide index diagrams and to suggest the character of illustrations which may be available. Isopachous diagrams are included when they have been published and may be conveniently adapted. The source is indicated in each case.--From introd.

Salt basins covered are: Arctic, Western Canada, Moncton-Malagash, Michigan, Ohio-New York, Paradox, Permian, Gulf Coast, Isthmian, Cuba, Enriquillo (Dominican Republic), Zipaqui-a (Colombia), Río Huallago (Peru), Manaus (Brazil), Aracaju (Brazil), Neuquén (Argentina).

2-3517. Ladd, Harry S., and Seymour O. Schlanger. DRILLING OPERATIONS ON ENIWETOK ATOLL: U.S. Geol. Survey, Prof. Paper 260-Y, p. 863-903, 24 illus., 3 maps, 2 charts, 2 secs. (in pocket), diag., 3 tables, 1960, 20 refs.

Shallow holes drilled on islands of Eniwetok Atoll showed that most of the near-surface sediments are unconsolidated except for beach rock at intertidal levels. Texture varies with organic composition, and depth to zones of leaching and recrystallization

are variable. One hole, mostly in solid rock to a depth of 130 ft., may have been drilled through the irregular but rigid reef framework that is thought to encircle the atoll; all other holes appear to be in lagoon deposits. Shallow holes on the reef flat entered a solid plate thicker than anything found under the islands.

Deep drilling revealed the presence of olivine basalt beneath shallow water limestone of Eocene age at a depth of more than 4,000 ft. The drilling of the first of 3 deep holes (K-1B) on the NE. side of the atoll was carried to a depth of 1,280 ft., ending in lower Miocene rocks; the other deep holes were put down on opposite sides of the atoll: F-1 on the NW, where a guyot adjoins the atoll at 700 fathoms, E-1 on the SE, where no guyot projects from the atoll. In F-1, hard basement rock was struck at 4,610 ft., but no sample was recovered. In E-1 unweathered basalt cuttings were obtained at 4,158 ft. and solid basalt core from 4,208 to 4,222 ft. Most of the sedimentary section was soft or weakly consolidated. The holes showed similar sections to depths of 1,400 ft., below which there were striking differences in lithologic character, organic constitution, and the distribution of hard rock and cavities. Starting at 2,900 ft., F-1 entered 1,000 ft. of Globigerina-rich limestone, apparently deposited in deeper waters than those in which the lagoonal sediments of E-1 were deposited.

The drilling revealed the occurrence of leached zones in which the aragonite of corals and most mollusks has been largely removed or recrystallized to calcite. These zones are thought to record periods when the top of the atoll stood above sea level and was subjected to atmospheric erosion. No aragonite was recognized below a depth of 2,020 ft. in F-1, nor below 2,808 ft. in E-1; in K-1B aragonite was found at a maximum depth of 1,230 ft.

In F-1, dolomite was found in the following depth intervals: 1,232-1,248; 2,662-2,687; 3,052-3,055; 4,197-4,222; 4,316-4,341; 4,406-4,431; 4,500-4,525; 4,528-4,553 ft. In E-1 dolomite was identified only from the 4,078-4,100-ft. interval; no dolomite was identified from K-1B.--Auth.

11. GEOHYDROLOGY

See also: Areal and Regional Geology 2-3153; Geomorphology 2-3219; Geochemistry 2-3461; Mineral Deposits 2-3533.

2-3518. U.S. Bureau of Reclamation, Design and Construction Division. STUDIES OF GROUND-WATER MOVEMENT: Its: Tech. Memo. no. 657, 180 p., maps, diags., graphs, tables, March 1960, 21 refs.

This technical memorandum is a collection of 19 selected office memoranda prepared by engineers of the Commissioner's Office, Denver, Colorado, on the studies of the technical problems arising from ground-water movement on U.S. Bureau of Reclamation projects. The memoranda, containing material which is believed not to be readily available elsewhere, have been edited and arranged under appropriate section headings for ready reference. The list of the original office memoranda and their corresponding section designations are given in the appendix.

Because of the continuing usefulness of the discussions, analyses, and mathematical treatment presented in the original memoranda, they are made available as guides to increased understanding of the

basic problems of ground-water movement and suggested solutions. Use of the mathematical derivations and formulas presented will require judicious evaluation in their applicability to specific problems.--Introd.

Section A. Well Pumping and Drainage Formulas.
Section B. Analysis of Pumping Test, Foundation Testing, Deer Creek Dam, Provo River Project, Utah
Section C. Analysis of Test Well Data Where the Water-Bearing Sand is Overlain by Beds of Low Permeability.

Section D. Formulas for Movement of Ground Water, Oahe Unit, Missouri River Basin Project.

Section E. Limitations of Drainage Formulas.

Section F. River Depletion Resulting from Pumping of a Well Near a River.

Section G. Methods of Estimating the Depletion of Flood Flows in Ladder Creek Resulting from Well Pumping.

Section H. Computation of Stream Flow Depletion to be Anticipated as a Result of Irrigation from Nearby Wells.

Section I. Methods of Estimating Possible Depletion of Flows in the Smoky Hill and North Solomon Rivers in Kansas Resulting from Well Pumping.

Section J. Seepage Estimate, Merritt Reservoir, Ainsworth Unit, Missouri River Basin Project.

Section K. Experimental and Theoretical Investigation of Seepage and Ground-Water Storage Possibilities at Mullen Damsite.

Section L. Inclusion of Water Returned from Banks During a Drawdown in the Operation Study of a Reservoir.

Section M. Methods for Estimating Changes of Ground-Water Levels Resulting from Deep Percolation Losses from Irrigation.

Section N. Methods of Computation of Quantity and Monthly Distribution of Return Flow, Kanopolis Unit, Missouri River Basin Project.

Section P. Drawdown in a One-Dimensionally Infinite Aquifer.

Section Q. Determination of Characteristics of a One-Dimensionally Infinite Aquifer from Drawdown Measurements.

Section R. Determination of Minimum Drawdown in a Square Array of Wells.

Section S. A Method of Estimating Drawdown Resulting from Well Pumping at Ingalls Project, Kansas.

Section T. Till Permeabilities as Estimated from Pump-Test Data Obtained During Irrigation Wells Investigations, Oahe Unit, Missouri River Basin Project.

2-3519. Hunt, Charles B., and Thomas W. Robinson. POSSIBLE INTERBASIN CIRCULATION OF GROUND WATER IN THE SOUTHERN PART OF THE GREAT BASIN (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B273, map, graphs, 1960)

Water discharging from large springs along fault zones in Death Valley, California, is chemically like water in neighboring and higher structural basins. It seems possible, therefore, that the water is derived from the neighboring basins and is reaching Death Valley in conduits along the faults.--Auth.

2-3520. da Costa, José A. WATER-LEVEL FLUCTUATIONS CAUSED BY MONTANA EARTHQUAKE: Am. Geophys. Union, Trans., v. 40, no. 4, p. 346, table, Dec. 1959.

The major earthquake of Aug. 17, 1959, near the Montana-Wyoming border had widespread effects on water levels and artesian pressures. Water-level fluctuations were automatically recorded in 136 U.S. Geological Survey observation wells in 21 states. The maximum was a rise of 10 ft. in a well 304 ft. deep located 85 mi. S. of Hebgen Dam, the approximate epicenter. Wells in Hawaii, 3,200 mi. distant, registered fluctuations up to 0.10 ft., and in the one well in Puerto Rico, 0.01 ft. The seismic fluctuations are caused mainly by Rayleigh waves. The data provide information on the elastic properties of artesian aquifers, an important factor in the development of ground-water supplies.--A.C. Mason.

2-3521. Giroux, P. R., and Ted Thompson. SUMMARY OF GROUND-WATER CONDITIONS IN MICHIGAN: Michigan, Geol. Survey Div., Water Supply Rept. no. 3, 77 p., 2 maps, 21 graphs, 2 tables, 1960.

This is the third in a series of reports covering ground-water levels and related hydrologic data in Michigan. The second report was listed as GeoScience Abstracts 1-1271. This report summarizes

and interprets, in part, the results of the program of measurement of ground-water levels and the collection of other pertinent hydrologic information by the U.S. Geological Survey. The program is part of the over-all water-resource investigation carried out in cooperation with the Geological Survey Division of the Michigan Dept. of Conservation. This report is based on periodic measurements of water levels made during 1958 in 207 wells, of which 33 were equipped with continuous recording gages. Tables list reported monthly and annual ground-water pumpage for various municipalities, institutions, and industries; also basic information for each observation well, and the extremes of water-level fluctuation in 1958 and for the period of record. Fluctuations of water levels in representative wells are shown by numerous hydrographs, and in many cases graphic interpretations of the changes in water levels are made by including pertinent climatic or pumpage data.--From introd.

The following topics are covered: precipitation and temperature; principles and summary of ground-water occurrence - causes of water fluctuation; summaries of ground-water conditions in the northern and southern peninsulas, by counties.

2-3522. Vanlier, Kenneth E. RECONNAISSANCE OF THE GROUND-WATER RESOURCES OF LUCE COUNTY, MICHIGAN: Michigan, Geol. Survey Div., Prog. Rept. no. 21, 76 p., 7 maps, sec., diag., 5 graphs, 5 tables, 1959, [pub. 1960], 20 refs.

Luce County is in the eastern part of the northern peninsula of Michigan. The northern two-thirds of the county is covered by forests and forested swamps and is largely undeveloped and relatively inaccessible. Most of the inhabitants reside in the southern part of the county. Lumbering and the tourist industry are the backbone of the county's economy.

The entire county is underlain by bedrock formations of Paleozoic age. These formations, consisting of sandstone, shale, limestone, and dolomite, are mantled throughout most of the county by Pleistocene glacial deposits composed predominantly of sand.

Although tapped by only a few wells, the Jacobsville sandstone of Early and Middle Cambrian age, the Munising sandstone of Late Cambrian age, and the Hermansville formation of Middle Ordovician age are important potential sources of potable water throughout the county. The water is contained in openings along joints and bedding planes where the rocks are fully cemented and also in voids between sand grains where they are uncemented or only partially cemented. These formations are near the surface in the northern part of the county but dip southward to a depth of 1,000 ft., or a little more.

The Black River and Trenton formations of Middle Ordovician age, the Richmond group of Late Ordovician age, the Cataract formation of Early Silurian age, and the Burnt Bluff formation of Middle Silurian age are tapped by wells where they are near the surface. Water in these formations is contained mainly in solution openings along joints and bedding planes. Generally the water is hard and, where readily soluble minerals such as gypsum or halite are present in the rocks, is highly mineralized. Where these rocks occur at depth or where solution openings have not been developed they are of low permeability, and the ground water contained in them generally is high in mineral content.

The glacial drift is the most important aquifer in Luce County and also has the greatest potential for future development. Both the surficial and buried

deposits of glacial outwash and sandy till in the drift are sources of large supplies of water. However, in some places in the county the drift consists of clayey till, which yields only meager amounts of water to wells, and in a few places the drift is missing or is too thin to be a source of supply. All the large-capacity wells in the county tap glacial drift, and probably the drift would yield large supplies of water in the parts of the county not yet developed.

Ground water of good quality is present throughout nearly all of the county. The ground water is predominantly of the calcium magnesium bicarbonate and calcium sulfate types. The sandstone and glacial-drift aquifers generally yield soft or only moderately hard water of good chemical quality. These aquifers, however, may yield water of poorer quality where they are connected hydraulically to other aquifers containing very hard or saline water. Locally, gypsum-bearing strata of the Richmond group and of the Cataract formation yield water high in Ca and sulfate. Well 45N 10W 9-4, which tapped rocks of the Richmond group, yielded water containing appreciable quantities of Na and chloride.

Although all the water used in the county is obtained from wells, the amount is only a small fraction of the available ground-water supply.--Auth.

2-3523. Sinclair, William C. RECONNAISSANCE OF THE GROUND-WATER RESOURCES OF SCHOOLCRAFT COUNTY, MICHIGAN: Michigan, Geol. Survey Div., Prog. Rept. no. 22, 84 p., 7 maps, sec., diag., 5 graphs, 6 tables, 1959, [pub. 1960], 14 refs.

Schoolcraft County is on the N. shore of Lake Michigan in the eastern part of Michigan's northern peninsula. The county is sparsely inhabited, most of the population being concentrated in the city of Manistique and other communities in the southern part of the county. The northern and central parts of the county are covered by forests and extensive swamps. The forest products and tourist industries are the backbone of the economy of the area.

The county is in the northern part of the Michigan basin, where Paleozoic rocks of Cambrian, Ordovician, and Silurian age form the bedrock surface. During the Pleistocene epoch, glacial ice, streams, and lakes deposited a wide variety of sediments over the bedrock surface. In some areas in the southern part of the county these sediments have been wholly or partly removed by erosion.

The best bedrock aquifers in the county are the sandstones of the Munising (Late Cambrian) and Hermansville (Late Cambrian and Early Ordovician) formations and the Manistique and Burnt Bluff formations of Niagara (Middle Silurian) age. Limestones and dolomites of the Richmond group and the Trenton and Black River limestones of Ordovician age may be sources of fresh water where they form the bedrock surface. These formations and the Cataract formation of Silurian age, however, commonly yield saline water, especially in areas where they are overlain by younger consolidated rocks.

Sand and gravel of glacial origin which mantle much of Schoolcraft County are important or potentially important aquifers. Glacial deposits consisting of silt and clay or sand and gravel containing significant amounts of clay are not important sources of ground water.

Adequate quantities of ground water of good quality are present in most of the county. However, various important aquifers containing water of good quality are covered or underlain by aquifers containing water of objectionable chemical quality. The glacial-

drift aquifers generally yield soft or only moderately hard water of the calcium magnesium bicarbonate type. The sandstone aquifers yield water of good quality in the N., but the Na and chloride content increases to an objectionable degree at the southern edge of the county. The Manistique and the upper member of the Burnt Bluff formation yield hard, but potable, water of the calcium magnesium bicarbonate type. Water in the Manistique and Gulliver areas, however, is subject to bacteriological contamination from surface sources, and the Burnt Bluff is hydraulically connected to the Cataract formation which contains water high in Ca and sulfate.--Auth.

2-3524. Hood, James W. GROUND WATER IN THE VICINITY OF THE ATLAS SITE, HOLLOMAN AIR FORCE BASE, OTERO COUNTY, NEW MEXICO: U.S. Geol. Survey, Repts., Open-File Ser., 42 p., 3 maps, diag., graph, 4 tables, 1960.

The Atlas Project site, near the E. side of the Tularosa basin, is situated on Tertiary and Quaternary bolson fill. The thickness of the fill probably exceeds 1,000 ft. beneath the site. The older fill is fine grained for the most part. Wells obtaining water only from the older fill probably would not yield more than about 100 g.p.m. The younger fill consists of sand, gravel, and clay deposited in alluvial fans which are superimposed on the older fill. Saturated sections of the alluvial fans yield appreciable quantities of water to irrigation wells in an area 4 to 6 mi. NE. of the Atlas site.

The anticipated maximum-water requirement for the Atlas Project is estimated at about 600,000 g.p.d. although initial requirements are set at 1.25 million gallons a week. The Special Test Track Facility will require about 120,000 g.p.d. The 2 projects will require a total maximum anticipated amount of 720,000 g.p.d. or about 750 g.p.m. based on a 16-hour pumping day. Existing supplies of water available to Holloman Air Force Base consist entirely of potable water, in part pumped from the Boles well field and in part purchased from the town of Alamogordo. Supplies obtained from the town are available only during the fall and winter months. The summertime peak demand at Holloman Air Force Base was about 1.8 m.g.d. in 1955. The peak demand in 1956 is expected to be higher. The current peak capacity of the Boles well field is about 2.1 m.g.d. based on a 16-hour pumping day, which indicates that the requirements of both test facilities cannot be met with surplus supplies from the Boles well field, and that additional supplies will need to be developed. If nonpotable water is used for the additional supplies, which would seem to be feasible because the quality of the water is not considered important, the potable-water supplies would be conserved.

The development of supplies of ground water in the vicinity of the Atlas and test track sites appears to be most feasible in the areas where thick sections of saturated alluvial fan materials are found. In these areas about 6 wells, including standby wells, would be required to meet maximum anticipated demands for both test sites. It is recognized that, for reasons of economy, it would be desirable to locate production wells at or near the storage facilities. Interpretation of existing data indicates that, if wells are constructed at the test sites, the maximum anticipated demands will require from 6 to 13 wells at the Atlas site, depending on length of daily pumping period, and 10 to 15 wells at the test track site. If storage facilities of 120,000 gallons capacity were placed at the test track site, the number of wells at

the site could be reduced to about 2 wells, based on a 16-hour pumping day.

Interpretation of existing data indicates that it may be necessary to go several miles E. of the Atlas site to obtain adequate supplies of ground water to meet maximum anticipated demand. It will be desirable to drill at locations shown on accompanying map to confirm existing data, most of which is reported.--Auth. summ.

2-3525. Herrick, Eugene H. RECONNAISSANCE OF GROUND-WATER CONDITIONS SOUTHEAST OF VALMONT, OTERO COUNTY, NEW MEXICO: U.S. Geol. Survey, Repts., Open-File Ser., 5 p., fold. map, 1960.

An area along the E. side of Tularosa basin, SE. of Valmont and N. of the Orogrande pipeline, in Otero County, has been suggested as a possible source of potable ground water. A reconnaissance was made of the area in Oct. 1956. It was restricted to the collection of readily available data from existing wells and a general reconnaissance of the topography and geology. The area investigated comprises about 150 sq. mi. adjacent to the Sacramento Mountains and NE. of the Jarilla Mountains, in the central part of Otero County. Some recommendations are made concerning the design of test holes; further geologic mapping is also suggested.--L. M. Dane.

2-3526. Ohio, Division of Water. WATER INVENTORY OF THE MAUMEE RIVER BASIN: Its: Ohio Water Plan Inventory, Rept. no. 11, 112 p., 46 pls. incl. illus., maps, graphs, 22 tables, March 1960.

The second in a series of studies planned to cover resources, problems, and possible solutions in 18 major drainage areas. The first report was listed as GeoScience Abstracts 1-2589. The text discusses the area and its economy; surface- and ground-water supply, quality, pollution; water use; flood problems; watershed management, drainage, erosion, soil conservation; future developments. Many maps, graphs, and tables facilitate interpretation of the data.--A. C. Sangree.

2-3527. Leggat, Edward R. MEMORANDUM ON GROUND-WATER CONDITIONS AND SUGGESTIONS FOR TEST DRILLING IN THE LOGAN HEIGHTS

AREA, EL PASO, TEXAS: U.S. Geol. Survey, Repts., Open-File Ser., 10 p., 3 maps, table, 1960, 2 refs.

Investigation was made to collect and evaluate pertinent available data on existing wells in the vicinity of Logan Heights and to determine the most promising locations for the installation of 2 wells capable of yielding a minimum of 800 g.p.m. (gallons per minute) each. General geology and ground-water occurrence are described, and the possibility of wells at 5 sites is discussed. Results of the investigation indicate that wells capable of yielding the required amount of water can probably be constructed at the recommended locations.--L. M. Dane.

2-3528. Newcomb, Reuben D., and Stuart G. Brown. EVALUATION OF BANK STORAGE ALONG THE COLUMBIA RIVER BETWEEN RICHLAND AND CHINA BAR, WASHINGTON: U.S. Geol. Survey, Repts., Open-File Ser., 19 p., 2 maps, 3 graphs, March 1960.

During the course of other hydrologic investigations at the Hanford Reservation of the Atomic Energy Commission, the bank-storage effect was noted. The bank storage is indicated by the uniform rise and decline of water levels in wells in agreement with the annual flood flow in the river. The rise in water levels is observed in a 100-sq. mi. zone along 50 mi. of the right bank of the Columbia River. The amount of water placed in bank storage by the high stages of the average annual flood is estimated to be approximately 170,000 acre-ft. Most of this water is removed directly from the river channel, whereas only about 1% is ground water prevented from entering the river. During a 45-day rise in the river, water from the river may infiltrate to the ground-water body at an average rate of about 3,700 acre-ft. per day. During the receding stages, an average of about 1,000 acre-ft. of this storage returns to the river per day. The bank storage along this reach of the river amounts to about 2/3 the volume placed in channel storage by the river's rise to the annual flood peak.

Because of known but unevaluated differences in geologic conditions along other parts of the main stem of the Columbia River, the values for bank storage in this 50-mi. area must be weighted properly before they are projected elsewhere along the stream.--Auth.

12. MINERAL DEPOSITS

See also: Geologic Maps 2-3149, 2-3150; Areal and Regional Geology 2-3185; Structural Geology 2-3233, 2-3234; Stratigraphy 2-3316; Geophysics 2-3347, 2-3361 through 2-3364, 2-3383, 2-3385, 2-3420; Geochemistry 2-3454, 2-3461; Igneous and Metamorphic Petrology 2-3489, 2-3493, 2-3496, 2-3497, 2-3498.

2-3529. Voskuil, Walter H. THE SEARCH FOR MINERAL ADEQUACY: Virginia Minerals, v. 6, no. 2, 7 p., Apr. 1960, 8 refs.

An intensive and comprehensively planned program of mineral exploration and discovery is the most important single factor in maintaining an adequate supply of available minerals.

This program requires the services of a large staff of geologists and geophysicists adequately equipped with the essential instruments of exploration.

Exploration, even though it results in substantial

discoveries, will not be adequate without the aid of the miners, metallurgists, engineers, architects, and contributions from deposits in foreign countries.--From auth.

2-3530. Smirnov, V. I. GEOLOGICAL BASES FOR THE EXPLORATION AND PROSPECTING OF ORE DEPOSITS (PART II, SECTIONS III AND IV). Translated by M. Irving Smith: Internat. Geology Rev., v. 2, no. 9, p. 739-762, 28 figs. incl. secs., diag., 2 tables, Sept. 1960.

This article is a translation of 2 sections of this book. The other sections are, for the most part, descriptions of well-known types of ore deposits, with a high proportion of the examples taken from American and other western deposits. Therefore, these sections are not being translated at this time.--E. Ingerson.

The Russian system of classification of ore reserves is defined; it includes 5 categories of reserves. Methods of estimating and designating the 4 main groups of ore deposits for the purpose of estimating reserves are described. Examples used include sedimentary marine Fe, Mn, and bauxite deposits; residual limonitic Fe ore, alluvial bauxite, magnetite skarn, Cu-bearing sandstones, stratified copper-nickel sulfides, vein disseminated Cu in secondary quartzite, lensing pyrite, hydrothermal ore vein, chromite, scheelite skarn, lateritic Ni ores, and placers.--M. Russell.

2-3531. Roach, Carl H. THERMOLUMINESCENCE AND POROSITY OF HOST ROCKS AT THE EAGLE MINE, GILMAN, COLO. (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B107-B111, 3 graphs, 1960) ref.

Thermoluminescence and porosity of host rocks adjacent to some ore bodies in the Eagle Mine, Gilman, Colorado, may be related to distance from ore and to alteration associated with ore.--Auth.

2-3532. Cannon, Helen L. BOTANICAL PROSPECTING FOR ORE DEPOSITS: Science, v. 132, no. 3427, p. 591-598, 5 illus., 5 tables, Sept. 2, 1960, approx. 80 refs.

The use of variances in plant growth over mineralized areas can be used as an indicator of the presence of ore bodies. Abnormal growth, mutation, or apparent malformation of plants are discernable manifestations of excesses of certain elements in soils. Very sensitive plants are especially useful as indicators, as are plants with deep roots or other specialized growth processes. Chemical analysis of carefully chosen indicator species which grow over wide areas may give indication of mineralization even when growth characteristics are not noticeably affected. This observational tool requires time and effort for development, which we in the United States are not yet devoting. It is to be noted that other countries have already begun work on this problem.--C.B. Schreiber.

2-3533. Canney, F.C., and D.B. Hawkins. FIELD APPLICATION OF ION-EXCHANGE RESINS IN HYDROGEOCHEMICAL PROSPECTING (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B89-B90, diag., 1960) 3 refs.

Light, durable plastic cartridges filled with ion-exchange resins may be used at the sample site to concentrate ionic constituents of large water samples and thus achieve greater over-all sensitivity; they also make it unnecessary to transport heavy, bulky samples, and prevent loss of ions from solution prior to analysis.--Auth.

2-3534. Griffiths, Wallace R., and H.M. Nakagawa. VARIATIONS IN BASE-METAL CONTENTS OF MONZONITIC INTRUSIVES (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B93-B95, map, table, 1960)

The base metal content of monzonitic intrusive rocks increases toward groups of veins (or groups of mineral deposits), largely because metals migrated outward from such centers of mineralization and into the monzonites. The abundance of metals in the ores of a particular metallogenic province may be

reflected in the primary or premineralization metal concentrations in the monzonites in the province.--Auth.

2-3535. Malyshev, V.I. DETERMINATION OF COEFFICIENTS OF RADIOACTIVE EQUILIBRIUM AS A METHOD OF STUDY OF THE MIGRATION OF URANIUM, IONIUM, AND RADIUM. Translated by Mark Burgunker: Internat. Geology Rev., v. 2, no. 10, p. 888-896, 4 diags., table, Oct. 1960, 15 refs.

The problems of study of the migration of U, ionium, and Ra by means of definition of quantitative correlation between these elements are considered. Ratios of U: ionium, Ra: U, and Ra: ionium are given for rocks and minerals of the hypergene zone of 3 different deposits.

The author elucidates the conduct of U, ionium, and Ra in the zone of hypergenesis of the examined deposits by means of a graphic method which facilitates considerably the interpretation of data obtained.--Auth.

2-3536. Danchev, V.I. THE IMPORTANCE OF QUANTITATIVE DETERMINATION OF COLOR IN THE STUDY OF SEDIMENTARY URANIUM DEPOSITS: Akad. Nauk SSSR, Izvestiya, Geol. Ser., in translation, 1958, no. 11, p. 60-71, 10 figs. incl. 2 maps, sec., graphs, pub. June 1960, 24 refs.

The paper presents data on the exact photometric determination of color in U-bearing carbonate rocks and analyzes the relation between color and the content of U compounds, organic matter, and various forms of Fe in the rocks.

The author concludes that the color of sedimentary rocks is an important indicator of the geochemical environment of their formation and therefore of the presence or absence of conditions favoring fixation of U compounds.--Auth.

2-3537. Griffiths, Wallace R., and U. Oda. GEOCHEMICAL PROSPECTING FOR BERYLLIUM (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B90-B92, map, graph, 1960)

The Be contents of alluvium and soil can be used as guides to outcrops of Be-rich rocks.--Auth.

2-3538. Chapman, Robert M., and Hansford T. Shacklette. GEOCHEMICAL EXPLORATION IN ALASKA (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B104-B107, map, 4 tables, 1960)

Soil, plant, and stream sediment geochemical sampling is useful in prospecting for sulfide-mineral deposits in Alaska. Soil and sediment generally show anomalies near deposits. Metal content of plants varies depending upon species, root depth, and kind and concentration of metal. Stream waters do not consistently give leads to deposits.--Auth.

2-3539. Hummel, C.L., and Robert M. Chapman. GEOLOGIC AND ECONOMIC SIGNIFICANCE OF SOME GEOCHEMICAL RESULTS OBTAINED FROM STREAM SEDIMENT SAMPLES NEAR NOME, ALASKA (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B30-B33, map, table, 1960) ref.

Meaningful geochemical results have been ob-

ained from stream sediment samples from the mineralized metamorphic terranes near Nome, Alaska. Anomalously high quantities of Cu, Zn, Bi, and Mo in sediment samples from Thompson Creek in the Kigluaik Mountains are of particular geological and economic significance as evidence of metalliferous nodules in an area not formerly known to contain them. --Auth.

2-3540. Shacklette, Hansford T. SOIL AND PLANT SAMPLING AT THE MAHONEY CREEK LEAD-ZINC DEPOSIT, REVILLAGIEDO ISLAND, SOUTHEASTERN ALASKA (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B102-B104, map, 2 tables, 1960)

Soil and plant samples were taken along 5 traverse lines that cross the vein of sphalerite and galena at Mahoney Creek. It was found that both classes of samples accurately reflect the known location of the mineral vein.--Auth.

2-3541. Bell, Henry, 3d. A SYNTHESIS OF GEOLOGIC WORK IN THE CONCORD AREA, NORTH CAROLINA (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B189-B191, map, 1960) 9 refs.

In the Concord area, North Carolina, geochemical and heavy-mineral reconnaissance, combined with geologic mapping, indicates that Au, W, and base metals were deposited during 2 periods of metallization, differing in their effects and associated with different rocks.--Auth.

2-3542. Erickson, Ralph L., and A.P. Marranzino. GEOCHEMICAL PROSPECTING FOR COPPER IN THE ROCKY RANGE, BEAVER COUNTY, UTAH (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B98-B101, 3 maps, 1960) 1 ref.

Preliminary results of geochemical prospecting on a small pediment in southwestern Utah suggest that a high Cu content in caliche as compared with alluvium may indicate a concealed Cu deposit in the underlying bedrock.--Auth.

2-3543. Cannon, Helen L. GEOCHEMISTRY OF SANDSTONES AND RELATED VEGETATION IN THE YELLOW CAT AREA OF THE THOMPSON DISTRICT, GRAND COUNTY, UTAH (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B96-B97, 3 tables, 1960) 2 refs.

A geochemical halo of U, V, As, Se, S, and Mo occurs in the rocks surrounding the ores in the Yellow Cat area. Two botanical methods of prospecting for these geochemical anomalies were developed and tested. Ore deposits were located by determining the U content of parts of trees and shrubs, and by mapping the distribution of Se-indicator plants.--Auth.

2-3544. Mackin, J. Hoover, and Earl Ingerson. AN HYPOTHESIS FOR THE ORIGIN OF ORE-FORMING FLUID (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B1-B2, 1960)

Replacement bodies of Fe ore occur in limestone around the borders of laccoliths of granodiorite porphyry in the Iron Springs district in southwestern

Utah. An hypothesis for origin of the ore-forming fluid holds that the Fe was incorporated in mafic minerals which crystallized in a deep magma chamber prior to emplacement of the laccoliths, and was released into the interstitial fluid of the consolidating laccoliths by deuteric decay of the mafic phenocrysts which were unstable in the new environment. Continued enlargement of the laccoliths during the period of consolidation caused the development of primary tension joints which served as passageways for outward movement of the Fe-enriched fluid. This deuteric-release hypothesis is applicable to the origin of ore-forming fluids in general.--Auth.

2-3545. Hummel, C.L. STRUCTURAL GEOLOGY AND STRUCTURAL CONTROL OF MINERAL DEPOSITS NEAR NOME, ALASKA (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B33-B35, map, 1960)

Structures of 2 systems differing in age have been identified in the bedrock of an area near Nome, Alaska. Lode and placer deposits of the Nome Au fields are closely associated with some of the structures of the younger system.--Auth.

2-3546. Sainsbury, Cleo L., and E.M. MacKevett, Jr. STRUCTURAL CONTROL IN FIVE QUICKSILVER DEPOSITS IN SOUTHWESTERN ALASKA (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B35-B38, 2 maps, 3 secs., diag., 1960)

Five quicksilver deposits in southwestern Alaska - the Red Devil, Kagati Lake, Red Top, White Mountain, and Willis - are similar in that all are mainly in competent rocks and were largely formed by filling of open spaces. Each deposit, however, is characterized by some special kind of structural control.--Auth.

2-3547. Heyl, Allen Van, Jr., and C.N. Bozior. VARIETIES OF SUPERGENE ZINC DEPOSITS IN THE UNITED STATES (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B2-B5, 3 secs., 1960) 18 refs.

Zn deposits of supergene origin are classified in order of their abundance: 1) mineralogically complex deposits replacing hypogene ore bodies - common in the North and West; 2) mineralogically simple deposits formed by supergene solutions in wall rocks of oxidizing sulfide bodies - common in the West; 3) saprolitic accumulations formed in warm, humid regions like the Southeast.--Auth.

2-3548. Fischer, Richard P., and John H. Stewart. DISTRIBUTION AND LITHOLOGIC CHARACTERISTICS OF SANDSTONE BEDS THAT CONTAIN DEPOSITS OF COPPER, VANADIUM, AND URANIUM (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B42-B44, chart, 1960) 8 refs.

Deposits of Cu are mainly in first-cycle arkosic sandstones; those rich in V are dominantly in second-cycle sandstones; and the U deposits are either in first- or second-cycle sandstones, commonly associated with beds containing altered volcanic ash. This distribution can perhaps be explained by the geochemical habits of these metals.--Auth.

2-3549. Bilibina, T.V., and others. METASEDIMENTARY URANIUM DEPOSITS IN PRECAMBRIAN

MARBLES AND CONTACT-METAMORPHIC ZONES.
Translated by Mark Burgunker: *Internat. Geology Rev.*, v. 2, no. 9, p. 763-768, 5 illus., Sept. 1960, 5 refs.

The present paper is a discussion of some aspects of the geology of the U deposits in lower Proterozoic carbonates of one district. The inference that U, P, and organic matter in the carbonates is of primary sedimentary origin comes from the fact that the U minerals are concentrated in only one stratigraphic zone of the thick lower Proterozoic sequence, that the uraninite is always intimately associated with apatite and graphitic matter, and that the greatest degree of U enrichment is encountered in intensely faulted zones. This type of U mineralization, apparently, is the result of the deposition, diagenesis, and subsequent metamorphism of the U-bearing sediments. Subsequently, regional metamorphism and folding created beds and lenses of U-bearing dolomitic marbles; the metamorphic processes also involved a redistribution and partial migration of the material in the rocks. A redistribution of U and its concentration in favorable structural zones was produced by the tectonic stresses associated with folding and shearing in the lower Proterozoic rocks. --J.K. Hartsock.

2-3550. Rosholt, John N., Jr. A STUDY OF URANIUM MIGRATION IN SANDSTONE-TYPE ORE DEPOSITS (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B41-B42, 1960) 5 refs.

U, as traced by its trail of daughter products, migrates by 1 of 4 different processes: 1) movement from oxidized bodies to carbonaceous materials, 2) outward dissemination, 3) downward movement following the water table, and 4) accumulation below ground-water saturation level. Geologic ages can be roughly estimated from the distribution of such daughter products, provided the age does not exceed 250,000 years.--Auth.

2-3551. Truesdell, Alfred H., and Alice D. Weeks. PARAGENESIS OF URANIUM ORES IN TODILTO LIMESTONE NEAR GRANTS, NEW MEXICO (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B52-B54, 3 illus., diag., 1960)

The Todilto limestone [Upper Jurassic] is locally replaced by minerals of U and V, and to a lesser extent by minerals of F, Fe, Pb, and other elements. Colloform uraninite, formed after early calcite, pyrite, fluorite, montroseite, haggite, and V clay, was accompanied or closely followed by coffinite, galena, and calcite, and was followed by late calcite, pyrite, marcasite, haggite, and hematite.--Auth.

2-3552. Granger, Harry C. PITCHBLEND E IDENTIFIED IN A SANDSTONE-TYPE URANIUM DEPOSIT IN THE CENTRAL PART OF THE AMBROSIA LAKE DISTRICT, NEW MEXICO (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B54-B55, 1960)

Pitchblende is very scarce in the central part of the Ambrosia Lake district, where the dominant U mineral is coffinite. The pitchblende here described is believed to have been derived from coffinite.--Auth.

2-3553. Weeks, Alice D., and D. Hoye Eargle. URANIUM AT PALANGANA SALT DOME, DUVAL COUNTY, TEXAS (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B48-B52, map, 2 secs., 2 graphs, 1960) 4 refs.

In the basal part of the Goliad sand (Pliocene), at a depth of 325 ft., U was precipitated from solution by reduction with H₂S emanating from the sulfurous caprock of the Palangana salt dome. The U appears to have been leached from the tuffaceous sediments updip by ground water containing alkaline carbonates.--Auth.

2-3554. Willden, Ronald. SEDIMENTARY IRON-FORMATION IN THE DEVONIAN MARTIN FORMATION, CHRISTMAS QUADRANGLE, ARIZONA (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B21-B23, map, table, 1960)

A deposit of oölitic hematite Fe-formation, averaging about 37% Fe over a strike length of 2,150 ft. and a thickness of 5 to 7 ft., was discovered in July 1959 near the top of the Martin formation about 12 mi. S. of Globe, Arizona.--Auth.

2-3555. Chao, Chia-hsiang, and Liu You-hsin. PRELIMINARY STUDY OF THE MANGANESE DEPOSITS OF CHINA. Translated by E.C.T. Chao: *Internat. Geology Rev.*, v. 2, no. 10, p. 833-850, 5 maps, 6 secs., Oct. 1960, 20 refs.

Exogenic Mn deposits in China occur in rocks of Precambrian, Devonian, Carboniferous, Permian, and Quaternary age. The 3 major types found are sedimentary, gossan, and residual; the most important deposits are Precambrian and Paleozoic marine sedimentary. Most of the ores occur in association with a stratigraphic hiatus in siliceous-carbonate facies of nearshore or lagoonal environment. S. China has the largest reserves and is the most promising area for future prospecting.--M. Russell.

2-3556. Chebotarev, M.V. GEOLOGICAL STRUCTURE OF THE SOUTH KHINGAN MANGANESE DEPOSIT AND ESSENTIAL COMPOSITION OF ITS ORES. Translated by E.A. Alexandrov and Assoc.: *Internat. Geology Rev.*, v. 2, no. 10, p. 851-866, 2 illus., 2 maps, secs., table, Oct. 1960, 4 refs.

The S. Khingan Mn deposits are geologically a part of the Malyy Khingan Mn-Fe ore district [Amur region, U.S.S.R.]. The geological sequence of the region consists of Precambrian and Lower Cambrian sedimentary, sedimentary metamorphic, extrusive and intrusive rocks. The lower series are exposed in anticlines intruded by granites. The Mn ores are confined to the base of the ferruginous quartzite ore horizon, which is located in the middle part of the Lower Cambrian ore-bearing series. The latter lies transgressively, but without apparent discontinuity, on the eroded surface of upper Sinian dolomites. The Mn ores are paragenetically associated with banded ferruginous quartzites and siliceous-argillaceous slates which contain variable amounts of dolomite of chemical or clastic origin. The banded ore structure is characterized by rhythmic interbedding of ore and barren bands from 0.10 to 10 cm. thick. The essential ore-body minerals are braunite, hematite, hausmannite, magnetite, rhodochrosite, chalcedony, quartz, clay minerals, and dolomite.

The major minerals forming the ore bands are braunite, hausmannite, and rhodochrosite. Barren material is composed of other minerals. Mineralogically the following ore types are distinguished: braunite and its varieties (hausmannite-braunite and braunite hematite), hausmannite-rhodochrosite, and siliceous rhodochrosite. In origin and mode of occurrence the Lower Cambrian Malyy Khingan Mn ores are similar to the marine Devonian Mn ores of central Kazakhstan. The Mn ores and overlying banded ferruginous quartzites are similar to the Mn ores and jaspilites of the Morro do Urukum in Brazil. --M. Russell.

2-3557. Hildebrand, Fred A. OCCURRENCES OF BAUXITIC CLAY IN THE KARST AREA OF NORTH-CENTRAL PUERTO RICO (In: U.S. Geological Survey. Geological Survey Research 1960: Its Prof. Paper 400-B, p. B368-B371, 2 maps, table, 1960) 5 refs.

Bauxitic clay occurs in sinkholes in the Lares limestone of Tertiary age along the S. edge of a karst belt near the N. coast of Puerto Rico. These clays, containing boehmite, possibly derived from Cretaceous volcanic rocks, are in sinkholes along a belt at least 14 mi. long and 3 mi. wide and contain about 25 to 40% Al_2O_3 and 10 to 18% Fe_2O_3 . --Auth.

2-3558. Owens, James P., and others. CONCENTRATIONS OF "ILMENITE" IN THE MIOCENE AND POST-MIOCENE FORMATIONS NEAR TRENTON, NEW JERSEY (In: U.S. Geological Survey. Geological Survey Research 1960: Its Prof. Paper 400-B, p. B57-B59, map, 2 tables, 1960) ref.

Relatively high concentrations of "ilmenite" [mixture of ilmenite and ferric and titanium oxides] occur in 2 Coastal Plain formations S. of Trenton, New Jersey. The Kirkwood formation, a marine quartz sand, contains a large volume of "ilmenite" moderately concentrated. The Cape May formation, a stream deposit, contains high concentrations but the deposits are small. --Auth.

2-3559. Sharp, W.N., and C.C. Hawley. BERTRANDITE-BEARING GREISEN, A NEW BERYLLIUM ORE, IN THE LAKE GEORGE DISTRICT, COLORADO (In: U.S. Geological Survey. Geological Survey Research 1960: Its Prof. Paper 400-B, p. B73-B74, 1960) ref.

Bertrandite-bearing greisen is a local variant of normal quartz-muscovite greisen in at least 2 places in the Lake George district. As the bertrandite is not conspicuous in greisen outcrops, similar occurrences of bertrandite in greisen elsewhere could have been overlooked. --Auth.

2-3560. Stager, Harold K. A NEW BERYLLIUM DEPOSIT AT THE MOUNT WHEELER MINE, WHITE PINE COUNTY, NEVADA (In: U.S. Geological Survey. Geological Survey Research 1960: Its Prof. Paper 400-B, p. B70-B71, 1960) 2 refs.

A replacement deposit in a limestone bed near the base of the Pioche shale [Cambrian] is characterized by phenacite, bertrandite, and beryl, intimately associated with scheelite and fluorite. --Auth.

2-3561. Kogan, V.D. ON THE RELATION BETWEEN DEPOSITION OF SULFUR AND FRACTURE TECTONICS: Akad. Nauk SSSR, Izvestiya, Geol. Ser., in translation, 1958, no. 11, p. 84-93, 6 figs. incl. maps, sec., diags., graph, 3 tables, pub. June 1960, 8 refs.

Detailed studies of the S-bearing layers in the Gurdak (Turkmen S.S.R.) deposits showed that the sulfuration process was closely connected with the system of fractures in the calcareous-anhydrite stratum of the deposit. These fractures were filled with epigenetic S in the Quaternary. --Auth.

2-3562. Knechtel, Maxwell M., and John W. Hosterman. BLOATING CLAY IN MIOCENE STRATA OF MARYLAND, NEW JERSEY, AND VIRGINIA (In: U.S. Geological Survey. Geological Survey Research 1960: Its Prof. Paper 400-B, p. B59-B62, map, 2 diags., 1960) 2 refs.

Argillaceous materials from the Coastal Plain were quick-fired in small electric kilns. Some samples expanded, yielding bloated products comparable in lightness, strength, water absorption, and color to aggregates produced elsewhere for preparation of lightweight concrete. Reconnaissance studies indicate thick deposits underlying extensive areas that include many prospective strip-mining sites. --Auth.

2-3563. Bannatyne, B.B. GYPSUM-ANHYDRITE DEPOSITS OF MANITOBA: Manitoba, Dept. Mines & Nat. Resources, Mines Branch, Pub. 58-2, 46 p., 2 illus., 4 maps, 3 secs., graph, 2 tables, 1959, 40 refs.

Gypsum is mined at Amaranth from the Middle Jurassic Amaranth formation and is quarried at Gypsumville from deposits of unknown age. The geology of these deposits is summarized. Gypsum has been intersected also at shallow depth in numerous wells.

Recent subsurface data show the Amaranth formation, averaging 100 ft. thick, extends under all of southwestern Manitoba. Correlation between the subsurface and earlier nearsurface data indicates the outcrop belt of the Amaranth extends from Dauphin Lake SE. to Portage la Prairie, SSE. to Gretna, and E. to Dominion City, but is everywhere covered by surface deposits from 10 to over 300 ft. thick. The possibilities of finding economic gypsum deposits within this belt are discussed; the most promising area is that between Amaranth and Elm Creek. Earlier reports of a thick gypsum bed in the Dominion City area have not been confirmed by recent drilling; gypsum occurs as thin beds, up to 14 ft. thick, interbedded with limestone and red shale.

The age of the Gypsumville deposits is unknown. The gypsum outcrops in several ridges over an area up to 10 mi. long and 8 mi. wide. The surrounding rocks are Silurian dolomites and Precambrian granitic and volcanic rocks; a small outcrop of granite is present near the center of the gypsum area. Intersections of gypsum reported from the upper part of the Silurian section E. of Lake Manitoba suggest a Silurian age for the Gypsumville deposits. Current annual production of gypsum in Manitoba is about 200,000 tons. --Auth.

2-3564. Swanson, Roger W. PHOSPHATE AND ASSOCIATED RESOURCES IN PERMIAN ROCKS OF

SOUTHWESTERN MONTANA (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B65-B66, map, 2 tables, 1960) 4 refs.

The phosphatic shales in southwestern Montana contain 450 million tons of phosphate rock in beds at least 3 ft. thick that contain more than 31% P_2O_5 , and 6 billion tons in beds at least 3 ft. thick that contain more than 24% P_2O_5 , though only a small part of this is minable at present. These shales contain more than 10 billion tons of P_2O_5 in rocks of all grades. The rock containing as much as 24% P_2O_5 also contains 2 1/2 to 3% F and small concentrations of U and other elements.--Auth.

2-3565. Berg, Henry C. **THREE AREAS OF POSSIBLE MINERAL RESOURCE POTENTIAL IN SOUTH-EASTERN ALASKA** (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B38-B39, map, 1960)

In the course of reconnaissance geological mapping in southeastern Alaska it was found that 2 areas on Admiralty Island and 1 in the Chilkat Range show more evidence of mineralization than the surrounding terrain. These areas contain deposits of sulfide and oxide minerals, which carry traces to major amounts of base metals, rare earths, Ti, Y, Z, and Nb.--Auth.

2-3566. Tweto, Odgen, and Paul K. Sims. **RELATION OF THE COLORADO MINERAL BELT TO PRECAMBRIAN STRUCTURE** (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B8-B10, map, 1960) 6 refs.

The Colorado mineral belt, characterized by intrusive rocks and ore deposits of Laramide age, is localized by shear zones of Precambrian origin. The shear zones underwent repeated movement during Precambrian, Paleozoic, and Mesozoic time, and became the locus of magmatic activity and ore deposition during the Laramide orogeny.--Auth.

2-3567. Steven, Thomas A., and James C. Ratte. **RELATION OF MINERALIZATION TO CALDERA SUBSIDENCE IN THE CREEDE DISTRICT, SAN JUAN MOUNTAINS, COLORADO** (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B14-B17, 2 maps, 1960) ref.

The Creede mining district, Colorado, is situated along a complex graben that extends northward out from an area of recurrent caldera subsidence. The main graben faults appear to contain the most important ore deposits.--Auth.

2-3568. Fryklund, Verne C., Jr. **ORIGIN OF THE MAIN PERIOD VEINS, COEUR D'ALENE DISTRICT, IDAHO** (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B29-B30, 1960) 10 refs.

The zoning patterns of minerals formed during the several stages of the Main period of mineralization in the Coeur d'Alene district indicate that the vein minerals came from 3 sources. Two of these may be magmatic; the third source may also be magmatic; however, there is a possibility that it is nonmagmatic.--Auth.

2-3569. Wallace, Robert E., and others. **TECTONIC SETTING OF THE COEUR D'ALENE DIS-**

TRICT, IDAHO (In: U.S. Geological Survey. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B25-B27, 3 maps, 1960) 4 refs.

The Coeur d'Alene mining district is in a structural knot at the intersection of N.-trending and E.-trending folds and is dominated by the Osburn fault which trends about N.80°W. A maximum of about 16 mi. of right-lateral strike slip is indicated by offsets along the fault of stratigraphic units, older structures, and ore-producing areas. The principal displacement probably occurred between 100 million years ago (Cretaceous) and middle Miocene time.--Auth.

2-3570. Weis, Paul L. **BLEACHING IN THE COEUR D'ALENE DISTRICT, IDAHO** (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B27-B28, 1960) 3 refs.

Large zones of bleached rock are the result of removal or destruction of principal pigmenting minerals by hydrothermal solutions. Alteration was apparently accomplished by warm nearly neutral water, widely separated both in origin and time of influx from the solutions that deposited the ores.--Auth.

2-3571. Trace, Robert D. **SIGNIFICANCE OF UNUSUAL MINERAL OCCURRENCE AT HICKS DOME, HARDIN COUNTY, ILLINOIS** (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B63-B64, 2 tables, 1960) 6 refs.

Monazite and florencite occur in surface samples of a steeply dipping breccia in Devonian limestone. Th, rare earths, Nb, Zr, and Be are present to depths of over 2,000 ft. These materials, and nearby mafic dikes, suggest deep-seated igneous activity in the Illinois-Kentucky fluorspar-Zn-Pb district.--Auth.

2-3572. Gulbrandsen, Robert A., and D.G. Gielow. **MINERAL ASSEMBLAGE OF A PYROMETASOMATIC DEPOSIT NEAR TONOPAH, NEVADA** (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B20-B21, table, 1960) 8 refs.

A deposit in Paymaster Canyon, about 13 mi. SW. of Tonopah, extends along a nearly vertical fault contact between Cambrian limestone and shale. The mineral assemblage is composed of manganianhedenbergite, andradite ($a_0 = 12.057 \text{ \AA}$), zincian nontronite, sphalerite (7.3% Fe), galena, magnetite, quartz, and calcite.--Auth.

2-3573. Roberts, Ralph J. **ALINEMENT OF MINING DISTRICTS IN NORTH-CENTRAL NEVADA** (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B17-B19, map, 1960) 2 refs.

The major mining districts of N.-central Nevada appear to lie within 2 zones of structural weakness, trending NW. Doming along these zones has formed windows in the upper plate of the Roberts Mountains thrust, which expose carbonate rocks favorable to mineralization in the lower plate. Most of the ore deposits are in these rocks, but some are in rocks of the upper plate but near the overthrust.--Auth.

2-3574. Castillo Tejero, Carlos, and Jose Angel Cuevas Roman. **CONSIDERACIONES SOBRE LA**

PLANEACION DE LA EXPLOTACION RACIONAL DE LOS RECURSOS MINERALES DEL SUELO Y DEL SUBSUELO [NOTES ON THE PLANNING OF THE RATIONAL EXPLOITATION OF THE MINERAL RESOURCES OF THE SURFACE AND SUBSURFACE]: Soc. Geol. Mexicana, Bol., v. 22, no. 1, p. 33-42, 1959.

The authors point out that a large part of Mexico is practically unexplored for minerals; that there are abundant deposits of many minerals that were formerly useless but now have industrial applications; that Mexico does not have smelters and refineries of sufficient capacity and quality for the growing needs of the country; and that the lack of

information on the mineral reserves has made it impossible for the Government to design a rational mineral exploitation policy.

A summary is given of the difficulties under which the Mexican mining industry has to operate and which have caused its constant decline in the last 30 years. A remedy is proposed in the creation of an autonomous bureau or a cabinet-rank department, which would centralize the government's functions in the mining industry, formulate its policy, give immediate execution to government resolutions, and would obtain sufficient budgets for the execution of its tasks. Finally, the article proposes an administrative outline of the organization of such a department or bureau.--R. van Vloten.

13. FUELS

See also: Areal and Regional Geology 2-3183, 2-3184, 2-3192; Stratigraphy 2-3273, 2-3275, 2-3280, 2-3282, 2-3294; Geophysics 2-3354, 2-3380, 2-3381, 2-3382, 2-3408, 2-3416, 2-3417, 2-3421, 2-3422; Geochemistry 2-3458, 2-3459, 2-3460.

2-3575. Heines, John T. **A BRIEF LOOK AT COMMERCIAL CORE ANALYSIS:** Alberta Soc. Petroleum Geologists, Jour., v. 8, no. 7, p. 207-212, July 1960.

At the well site the core is inspected and prepared for transporting to the laboratory. In the laboratory the core is described, and representative samples are selected for the analysis of the physical characteristics of the rock. Additional samples are selected for the measurement of the core fluid saturation. The samples to be used for measuring the porosity and permeability are cut to the proper size, cleaned to remove the contained oil and/or water and dried. Upon completion of the necessary measurements and calculations the results are reported to the company requesting the analysis.--Auth.

2-3576. Castillo Tejero, Carlos. **CONSIDERACIONES SOBRE EL EXAMEN DE LAS MUESTRAS PROVENIENTES DE LA PERFORACION DE POZOS [NOTES ON THE STUDY OF SAMPLES FROM WELL DRILLING]:** Soc. Geol. Mexicana, Bol., v. 22, no. 1, p. 65-72, 1959.

A theoretical review on treatment and study of drilling samples.--R. van Vloten.

2-3577. Pressman, A. E. **PHOTOGEOLOGY SPEEDS UP GROUNDWORK FOR OIL HUNTERS:** Oil & Gas Jour., v. 58, no. 37, p. 162-168, 6 maps, Sept. 12, 1960, 6 refs.

A survey of applications of photogeology, with examples of anomalies indicated by a radial drainage pattern, of phototectonic maps prepared with the aid of photogrammetric plotters, and the use of aeromagnetic maps. Other examples show how structure contour maps and isopachous maps might be prepared, and how fracture maps may be used.--N. Street.

2-3578. Pierce, Arthur P. **STUDIES OF HELIUM AND ASSOCIATED NATURAL GASES (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B77-B79, 3 graphs, 1960) 5 refs.**

The available data show that the He and N contents

of gas fields tend to increase with the age of the gas-producing rocks. Calculations of the rate of He generation and migration indicate that it has probably been derived from decay of trace amounts of U and Th in adjacent source rocks. Similarly, the N may be accounted for by slow degradation of nitrogenous compounds present in the same rocks.--Auth.

2-3579. Zappa, Theodore A. **ALASKA - THE NEXT BIG OIL STATE?:** Oil & Gas Jour., v. 58, no. 34, p. 128-131, illus., Aug. 22, 1960.

Alaska geology indicates the existence of tremendous basins, 125,000,000 acres of land area and 50,000,000 acres of offshore area. There has been drilling success for both oil and gas. Alaska possesses economic advantages over foreign oil in that there are no import restrictions, royalty terms are favorable, the markets are immediate, and political stability is guaranteed. There are some advantages over other domestic oil in that there are no production limitations and it is close to the immediate markets of the West Coast and the future markets of all the Far East.--N. Street.

2-3580. Burgess, Richard J. **OIL IN TRENTON SYNCLINES:** Oil & Gas Jour., v. 58, no. 33, p. 124-131, 15 figs. incl. maps, secs., 2 tables, Aug. 15, 1960.

The Trenton-Ordovician synclines have become a major exploratory target in the last 2 years. Michigan's Scipio-Albion trend promises to become a major field. The 3 producing synclinal fields (Dover, Scipio-Albion, and Colchester) are described and evidence presented to show that they are very similar and form a definite type of stratigraphic trap. Suggestions regarding the origin are offered and the applicability of various exploration tools is discussed.--N. Street.

2-3581. Wellings, F. E. **WHICH HOLDS THE HIGH CARDS - NORTH AFRICA OR MIDDLE EAST?:** Oil & Gas Jour., v. 58, no. 28, p. 80-85, 3 maps, sec., July 11, 1960.

Middle East oil fields are famous for high production per well, large reserves, and big pools. Exploration was delayed in the North African deserts because of lack of surface structures, their remoteness, and various political factors. The concession terms are less attractive in North Africa. Probably as much oil could be found in certain Middle East

countries as in North Africa with the same drilling effort. By 1965 the North African capacity might amount to 50 million tons per year and compete with the Middle East for the European market.--N. Street.

2-3582. Kremp, G.O.W., and Anton J. Kovar. THE INTERPRETATION OF TERTIARY SWAMP TYPES IN BROWN COAL (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B79-B81, chart, 1960) 12 refs.

"Sedge swamps" and "Myricaceas-Betulaceae swamps" of German coals do not correspond to modern swamp types in Florida, as formerly supposed.--

Auth.

2-3583. Averitt, Paul. COAL RESERVES OF THE UNITED STATES, JANUARY 1, 1960 (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B81-B82, table, 1960) 11 refs.

The coal reserves of the United States remaining in the ground on Jan. 1, 1960, totaled 1,660,290 million tons, and recoverable reserves totaled 830,145 million tons, assuming 50% recovery. The figures are based largely on recent estimates in 26 states.--Auth.

14. ENGINEERING GEOLOGY

See also: Geologic Maps 2-3143, 2-3144; Geomorphology 2-3225; Geochemistry 2-3435, 2-3436; Geohydrology 2-3518.

2-3584. Shoemaker, Eugene M. BRECCIATION AND MIXING OF ROCK BY STRONG SHOCK (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B423-B425, diag., 1960) 5 refs.

Mixing motion extends outward from the origin of the shock to a fairly sharply defined limit. The relation between this distance (R) and the total energy released (W), within the limits of uncertainty of the data, is given by the equation

$$\frac{R \text{ (in feet)}}{\sqrt[3]{W \text{ (in tons TNT equivalent)}}} = 5.7.$$

--Auth.

2-3585. Wilmarth, Verl R., Theodore Botinelly, and Ray E. Wilcox. ALTERATION OF TUFFS BY RAINIER UNDERGROUND NUCLEAR EXPLOSION, NEVADA TEST SITE, NYE COUNTY, NEVADA (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B149-B151, table, 1960) 7 refs.

The high temperatures and pressures of the Rainier explosion formed radioactive glass in the surrounding breccia zone. The brecciated tuffs are cut by irregular veinlets of comminuted and partly fused tuff, which decrease in size and abundance outward from the breccia. Mineralogical changes in the tuffs other than melting are slight.--Auth.

2-3586. Wilmarth, Verl R., and Francis A. McKeown. STRUCTURAL EFFECTS OF RAINIER, LOGAN, AND BLANCA UNDERGROUND NUCLEAR EXPLOSIONS, NEVADA TEST SITE, NYE COUNTY, NEVADA (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B418-B423, 5 maps, 6 secs., graph, 1960) 2 refs.

Three underground nuclear explosions in tuff produced faults and fractures that are visible on the surface and in the still-accessible parts of underground workings and ellipsoidal breccia zones around the explosion chambers. The distribution of the faults and fractures and the volumes of the breccia zones are related to the physical properties of the tuff, which differ in different places.--Auth.

2-3587. Osterwald, Frank W., and Harold Brodsky. TENTATIVE CORRELATION BETWEEN COAL

BUMPS AND ORIENTATION OF MINE WORKINGS IN THE SUNNYSIDE NO. 1 MINE, UTAH (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B144-B146, map, 2 diags., 1960) 9 refs.

Coal mine bumps endanger and at times destroy life and property in mines of the Book Cliffs coal field, Utah. In the Sunnyside No. 1 Mine, bumps seem to be more frequent but less violent where mine workings intersect fracture zones at small angles than where they intersect them at large angles. This correlation is probably due to differential stress accumulation in coal between the workings and the fractures.--Auth.

2-3588. Leighty, Robert D., and Ambrose O. Poulin. ICE-CAP ACCESS ROUTE, NARSSARS-SUAQ, GREENLAND - LOCATION AND ENGINEERING EVALUATION: U.S. Snow, Ice & Permafrost Research Establishment, Tech. Rept. 48, 36 p., 62 illus., map, 3 tables, May 1960, refs.

In 1956 a reconnaissance of the southwestern coast of Greenland was conducted for the purpose of selecting an area which would provide year-round access to the ice cap. During the summer of 1957 the terrain between Narssarsuaq and the ice cap was studied in detail and an overland route from the air base to the ice cap was located and surveyed.

The route is approximately 45 mi. long and extends from the bridge crossing at the air base, which is near sea level, to the ice cap, at a ground elevation of 3,942 ft. at the end of the surveyed route. The location established utilizes to best advantage the natural terrain slopes and materials. The selected location is such that about 95% of the grades will be 6% or less and none will exceed 10%. Two locations will require switchbacks because of steep natural slopes. Nine bridges will be required along the route, with a combined length estimated at 1,260 ft. Three of them may be in excess of 100 ft. each. Foundations in rock will be available for 7 bridges while gravel with boulders will provide the foundation for 2.

The topography throughout most of the route is quite rough and has resulted in severe problems of grade and alignment. For the most part the route is on rocky terrain, and earthwork will necessitate considerable blasting throughout much of the route. The rocks are predominately jointed and fractured, fine to medium grained granite with felsitic and basalt intrusions in the form of dikes and small stocks occurring at scattered locations. Some metamorphic rocks occur near Gannet bay. Where the

MISCELLANEOUS

route has been placed on side slopes, blasting of large boulders and talus materials will be a problem of some magnitude. At many locations there are good sources of granular materials which can be utilized on an economical haul basis.

The report discusses 1) the physical characteristics of the terrain between Narssarssuaq and the ice cap, 2) illustrated description and general engineering analysis of the entire route, section by section, 3) possible alternate routes, and 4) recommendations for continued study. Because of space, data concerning plan, profile, and cross-sections as obtained by and prepared by personnel of USA EATF have not been made a part of this report. Such data are available from the Commanding Officer of that organization.

Recommendations for future work prior to construction include obtaining large-scale aerial photography of the route and additional information of important areas and possible alternates along the route. Additional recommendations are given for a camp area near the ice-cap access point and design considerations for the road.--Auth. summ.

2-3589. Weaver, Mary A., and Dorothy H. Radbruch. **SELECTED LOGS OF BORINGS ON THE EAST SIDE OF SAN FRANCISCO BAY, CALIFORNIA:** U.S. Geol. Survey, Repts., Open-File Ser. no. 585, 213 p., map (in pocket) scale 1:36,000, logs, 1960.

Four hundred fifty-six logs of borings are described and are plotted on topographic quadrangle maps of the E. side of San Francisco Bay. Each log gives the location, date of boring, ground-surface elevation, depth of each unit from the surface, thickness of each unit, descriptions of material in the holes, and field and laboratory test data if available.--Auth.

These logs will be of use to engineers, contractors, foundation designers and builders in the San Francisco Bay region, for they tell what kind of earth material may be found beneath the surface in a large area on the E. side of the bay. In many places, the logs show that the surface is underlain by very trou-

blesome foundation material, such as soft bay mud.--U.S. Geol. Survey.

2-3590. Allen, Alice S. **REVIEW OF THE CAUSES OF SUBSIDENCE** (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B147-B148, 1960) 17 refs.

Presently recognized causes of subsidence include compaction of soil and subsurface materials, progressive readjustment around cavities, geochemical changes, melting, lateral migration of subsurface material, and contemporary tectonic disturbance.--Auth.

2-3591. Bonilla, M.G. **A SAMPLE OF CALIFORNIA COAST RANGE LANDSLIDES** (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B149, 1960) 2 refs.

In the San Francisco South quadrangle, debris slides and earthflows are numerous, but complex landslides have affected a greater area, and slides of several other types have occurred. Slope debris, consisting mostly of stony clay, is involved in about 1/3 of the landslides. More than 1/3 have occurred on slopes of 20° to 25°.--Auth.

2-3592. Greene, Gordon W., Arthur H. Lachenbruch, and Max C. Brewer. **SOME THERMAL EFFECTS OF A ROADWAY ON PERMAFROST** (In: U.S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B141-B144, 2 diags., 2 graphs, table, 1960)

Modifications of natural heat exchange at and near the surface, caused by building a roadway on permafrost, increase the variation in subsurface temperatures from summer to winter and from year to year. This causes a progressive thickening of the active layer. Movement of soil moisture following thawing of permafrost often results in costly settlement and heaving of the roadway.--Auth.

15. MISCELLANEOUS

2-3593. Livingston, Alfred, Jr. **INTRODUCTION TO GEOLOGY (AN OUTLINE):** rev. ed., 55 p., illus., secs., diags., Palo Alto, California, N-P Publications, 1960.

This outline was prepared to present to the student the fundamental principles of the most important concepts in geology and to provide him with a vocabulary which makes it possible for him to delve further into the subject. "Examples" are almost completely eliminated from the text.--From introd.

The outline covers the following subjects: materials of crust, weathering, mass wasting, structure of the earth's crust, running water, underground water, the oceans, wind action, glaciers, diastrophism, earthquakes, volcanoes, mountain making, metamorphism, lakes and swamps.

2-3594. Kupsch, W.O. **ANNOTATED BIBLIOGRAPHY OF SASKATCHEWAN GEOLOGY (1823-1958 INCL.):** Saskatchewan, Dept. Mineral Resources, Rept. no. 9, (rev. ed., 1959), 199 p., 2 maps (1 fold.), diag., 1960.

This bibliography lists references dealing with

the geology of Saskatchewan from 1823 to and including 1958. It replaces the first edition of Rept. no. 9, published in 1952, and the Supplement, published in 1954 by the Saskatchewan Dept. of Mineral Resources.

The references are arranged alphabetically by author and are accompanied by short annotations taking the form of expanded titles, rather than synopses of the scientific investigations dealt with in the references.

Indexes to the titles are provided according to geographic area, as well as subjects. All published geologic maps and descriptive well logs of any part of the stratigraphic section are indexed separately.

An index map of Saskatchewan according to the National Topographic System has been added to facilitate the location of geographic areas.--Auth.

2-3595. U.S. Geological Survey, Military Geology Branch. **BIBLIOGRAPHY OF THE MOON:** 170 p., Washington, D.C., July 1960.

This bibliography of approximately 2,500 references was compiled under the direction of Intelligence

and Mapping Division, Office of the Chief of Engineers, U.S. Dept. of the Army, in connection with the preparation of the Engineer Special Study of the Surface of the Moon (see GeoScience Abstracts 2-2803). The bibliography pertains to the moon as a physical object; attention was not directed to movement of the moon as a heavenly body or to its effect on the earth. Entries are listed alphabetically by authors; no subject index is included because of the singleness of purpose.--From intro.

2-3596. U.S. Geological Survey. **GEOLOGICAL SURVEY RESEARCH 1960: Its Prof. Paper 400**, 2v.: 136 p., 515 p., illus., maps, secs., diags., graphs, tables, 1960, refs.

The activities of the U.S. Geological Survey encompass projects that span the full range of the geological sciences. The volume and complexity of such a research program make it difficult to review, coordinate, and release the results of the work as quickly as is desirable; as a result considerable time normally elapses between the completion of many investigations and the publication of the final reports. And yet this same volume and complexity make it the more essential that some means be found to digest and make available to all the new ideas and new discoveries that have been achieved.

In an effort to help solve this problem the present volume has been prepared; it summarizes the results of the recent work of the Geologic Division of the Survey. The report consists of 2 main parts: Chap. A, "Synopsis of Geologic Results," is primarily a summary of important new findings, either as yet unpublished or published during the fiscal year 1960 - the 12 months ending June 30, 1960. It also includes a list of investigations in progress during that period, along with the names and headquarters of those in charge of each, and a list of reports published or otherwise made available to the public during the same period. Chap. B, "Short Papers in the Geological Sciences," consists of 232 papers, generally less than 1,000 words in length. These are of 2 kinds. Some papers are primarily announcements of new discoveries or observations on problems of limited scope, regarding which more detailed and comprehensive reports may or may not be published later. Others summarize the conclusions drawn from extensive investigations that have been in progress for some time; these conclusions in large part will be embodied in much longer reports that will be published later.

This report is an experiment. Although both chapters in this volume deal largely with the work of the Geologic Division, it is hoped to expand the scope of the report in future years to include results obtained by other Divisions of the Geological Survey, and to issue it annually.--From foreword by T.J. Nolan.

The 232 papers contained in Chap. B are abstracted separately in this issue of GeoScience Abstracts under the proper subject sections.

2-3597. Quam, Louis O. **ARCTIC DRIFTING STATION: Am. Geophys. Union, Trans.**, v. 40, no. 3, p. 222-224, Sept. 1959, ref.

Scientific stations have been established on the permanent ice pack of the Arctic Ocean to determine the nature, thickness, and movement of sea ice; the circulation, temperature, salinity, and acoustic characteristics of the sea water; and the nature of the ocean. The first station was established by the

Russians in 1937 at the North Pole; the U.S. Air Force occupied a research station in 1952 on Ice Island T-3, then 100 mi. from the Pole. Brief landings on pack ice by ski-equipped aircraft have also permitted more than 600 observations since 1937 by the Russians, and about 50 by the Arctic Research Laboratory operating from Point Barrow, Alaska, since 1950. During the International Geophysical Year 1957-1958, the Soviet Union and the United States each occupied a station on an ice island and on an ice floe. The ice-island stations are still occupied, but both ice-floe stations have been abandoned because of ice breakup. Both countries reestablished ice-floe stations in Apr. 1959, the United States' Station C at 75°02'N.-158°30'W. on an oval floe about 4 by 7 mi. The station is supported by the U.S. Office of Naval Research, U.S. Air Force Cambridge Research Center, and U.S. Navy Underwater Sound Laboratory, and the U.S. Navy Hydrographic Office, which observes differential movement of floes to determine convergence and divergence within the ice pack. Under contracts, the U.S. Weather Bureau operates a weather observing and radiosonde station; the University of Washington studies the sea-ice heat budget, sea-ice physics, and oceanography; the University of Alaska operates an all-sky camera and an aurora spectrophotograph; and the Lamont Geological Observatory conducts geophysical and sea-bottom studies. Up to June 1, 1959, the station has drifted NW. averaging 2 nautical mi. per day.--A.C. Mason.

2-3598. Crary, A.P. **ANTARCTICA: Am. Geophys. Union, Trans.**, v. 40, no. 4, p. 331-339, map, Dec. 1959, 8 refs.

Research on Antarctica is the result of world-wide joint efforts by 66 nations attacking global scientific problems during the International Geophysical Year. During planning, the continent of Antarctica held a dominant role, as it contains 29% of the land in the southern hemisphere and a large part of global geophysical problems. Operations consisted of observations supplementing world-wide data and those concerned with the continent itself, particularly glaciological, as Antarctica contains 90% of the world's ice. Annual mean precipitation over Antarctica is only about 6 cm. in water equivalent. W. Antarctica (facing western hemisphere) has surfaces up to 2,000 m., and temperatures average down to about -30°C. (extreme rarely below -56°C.). E. Antarctica is larger, higher, and colder; the South Pole is on the fringe, elevation 2,900 m., average annual temperature of -50°C. (lowest -76°C.). Based on information from the U.S.S.R. Vostok inland station, elevations reach nearly 4,250 m. and temperatures -87°C., lowest recorded on earth. W. Antarctica, stripped of its snow cover, would be an archipelago of mountainous islands, even allowing for isostatic rise. The Ross ice shelf and the Filchner ice shelf, which is almost as large, are nearly completely floating over deep water. A shelf thickness of more than 900 m. was measured near the Liv glacier. In E. Antarctica the land is generally above sea level; near its center, at an elevation of 3,700 m., the Russians measured an ice thickness of 2,900 m. A special committee on Antarctic research has been formed to continue the international cooperation.--A.C. Mason.

2-3599. Fischer, William A. **SPECTRAL REFLECTANCE MEASUREMENTS AS A BASIS FOR FILM-FILTER SELECTION FOR PHOTOGRAPHIC**

DIFFERENTIATION OF ROCK UNITS (In: U. S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B136-B138, 4 illus., diag., 1960)

Laboratory measurements of spectral reflectances from rocks of several types are significantly different, and they are helpful in selecting the film-filter combinations that will best reveal the differences between certain rocks photographically.--Auth.

2-3600. Hackman, Robert J. TECHNIQUE FOR VIEWING MOON PHOTOGRAPHS STEREOSCOPICAL-

LY (In: U. S. Geological Survey. Geological Survey Research 1960: Its: Prof. Paper 400-B, p. B139-B141, illus., 2 diags., 1960)

Photographs of the moon taken at different libration positions have an angular difference of view which permits stereoscopic viewing when geometric centers of curvature and their conjugate image points are aligned. Enlarged moon photographs can be cut into hexagonal sections and, by means of predetermined reference points on each, can be properly oriented for stereoscopic viewing with a desk-type stereoscope.--Auth.

AUTHOR INDEX

Abstract	Abstract
bb, E.A. 2-3412	Chao, Chia-hsiang 2-3555
fanasev, G.D. 2-3491	Chao, Edward C.T. 2-3473
hnert, Frank 2-3222	Chapman, Robert M. 2-3538, 2-3539
llen, Alice S. 2-3590	Chebotaiev, M.V. 2-3556
llingham, John W. 2-3356, 2-3357	Christiansen, E.A. 2-3153
ltenhofen, Robert E. 2-3366	Clark, Lorin D. 2-3255
ltschuler, Z.S. 2-3507	Cobban, W.A. 2-3297
lvarez, Manuel, Jr. 2-3265	Comité de la Carta Geológica de México 2-3151
lvord, Donald C. 2-3243	Coolidge, John E. 2-3417
mirkhanov, Kh. I. 2-3466	Coulter, Henry W. 2-3315
nderson, L.A. 2-3383	Cox, Allan V. 2-3367
ndreasen, Gordon E. 2-3351, 2-3354, 2-3429	Crandell, Dwight R. 2-3480
ndreev, T. 2-3406	Crary, A.P. 2-3598
ndreeva, I.B. 2-3252	Cuevas Roman, Jose Angel 2-3574
nifsgard, H.W. 2-3159	Cuttitta, Frank 2-3432, 2-3437, 2-3444, 2-3445, 2-3446, 2-3463
nnell, C.S. 2-3430	
pplin, Esther R. 2-3302	
pplin, Paul L. 2-3294	
rndt, Harold H. 2-3254	
ssociation of Missouri Geologists 2-3157	
veritt, Paul 2-3583	
achman, George O. 2-3287	da Costa, José A. 2-3520
ader, Henri 2-3200	Danchev, V.I. 2-3536
alakina, L.M. 2-3395	Dane, Carle H. 2-3298
annatyne, B.B. 2-3563	Davies, William E. 2-3473
arnes, David F. 2-3199	Davis, Robert E. 2-3243
arnett, Paul R. 2-3452	Davis, W.E. 2-3347
arry, George S. 2-3152	de la Montagne, John 2-3171
ates, Robert G. 2-3358	de Mille, George 2-3246
ath, Gordon D. 2-3368	Deutsch, E.R. 2-3250
axter, Robert W. 2-3332	Dickey, Dayton D. 2-3405
beck, Frederick M. 2-3167	Dietz, Robert S. 2-3248
becker, Herman F. 2-3181	Diment, W.H. 2-3389, 2-3404, 2-3423, 2-3428
ell, Henry, 3d 2-3149, 2-3189, 2-3150	Dinnin, Joseph I. 2-3447
	Dmitriev, V.I. 2-3377
ell, Kenneth G. 2-3456	Doell, Richard R. 2-3366, 2-3367
eloussov, V.V. 2-3227	Dorf, Erling 2-3182
enson, Carl S. 2-3201	Drake, Avery A., Jr. 2-3243
erg, Henry C. 2-3565	Drewes, Harald D. 2-3230, 2-3235
ergendahl, M.H. 2-3155	Dyakonov, B.P. 2-3374
ernstein, V.A. 2-3426	
ezborodov, R.S. 2-3260	Eardley, A.J. 2-3163
ezsmertnaya, M.S. 2-3498	Eargle, D. Hoyer 2-3553
ilibina, T.V. 2-3549	Edwards, R.G. 2-3293
illings Geological Society 2-3159	Ekren, E.B. 2-3379
oardman, Richard S. 2-3323	Elston, Donald P. 2-3242
ogdanov, A.A. 2-3261	Ennshtein, B.S. 2-3378
onilla, M.G. 2-3591	Engel, Albert E.J. 2-3497
oozer, G.D. 2-3424	Engel, Celeste G. 2-3497
otinelly, Theodore 2-3515, 2-3585	Erickson, Ralph L. 2-3542
ower, Margaret E. 2-3352	Eugster, Hans P. 2-3478
ozion, C.N. 2-3547	Evans, Howard T., Jr. 2-3469
ragg, W.L. 2-3468	Ewing, Maurice 2-3203
rewer, Max C. 2-3592	Ez, V.V. 2-3390
riggs, Reginald P. 2-3239	
rodsky, Harold 2-3587	Farley, Thomas Albert 2-3465
romery, Randolph W. 2-3359	Farquhar, R.M. 2-3464
rosgé, William P. 2-3278	Fedoseenko, N.E. 2-3386
rown, C.E. 2-3289	Field Conference of Pennsylvania Geologists, 25th, Lancaster, 1960 2-3188
rown, R.J.S. 2-3416	Filippov, E.M. (Fillippov) 2-3415
rown, Robert D., Jr. 2-3296	Fischer, Richard P. 2-3548
rown, Stuart G. 2-3528	Fischer, William A. 2-3599
rusilovsky, S.A. 2-3494	Fisher, Richard V. 2-3304
ryant, Bruce H. 2-3236	Flanagan, Francis J. 2-3471
ukhteev, V.G. 2-3406	Foster, Helen L. 2-3317
ulashevich, Yu. P. 2-3414	Fox, Sidney W. 2-3319
unker, Carl M. 2-3423	Fraser, George D. 2-3513
urbank, Wilbur S. 2-3247, 2-3489	Frisknecht, Frank C. 2-3379
urgess, Richard J. 2-3580	Frost, Irving C. 2-3450
urns, James R. 2-3451	Fryklund, Verne C., Jr. 2-3568
ampau, D.E. 2-3159	Gamson, Bernard W. 2-3416
ampbell, Russell H. 2-3284	Gard, Leonard M., Jr. 2-3512
annev, F.C. 2-3533	Geological Society of America, Rocky Mountain Section 2-3190
annon, Helen L. 2-3532, 2-3543	Georgiev, Milan 2-3225
arroll, Dorothy 2-3441, 2-3442	Gibbons, Anthony B. 2-3515
ase, James E. 2-3241	Gielow, D.G. 2-3572
astillo Tejero, Carlos 2-3574, 2-3576	Gill, James R. 2-3457
ater, Fred W., Jr. 2-3503	Gilluly, James 2-3257
	Giroux, P.R. 2-3521
	Gleason, Sterling 2-3467

- Glover, Lynn, 3d 2-3240, 2-3510
 Godovikov, A.A. 2-3472
 Gold, L.W. 2-3198
 Good, John M. 2-3307
 Goodman, A.J. 2-3253
 Gorder, John D. 2-3184
 Gorskho, G.S. 2-3481
 Gorzhevsky, D.I. 2-3498
 Granger, Harry C. 2-3552
 Grant, U.S., IV 2-3337
 Grantz, Arthur 2-3295, 2-3354, 2-3355
 Gray, Carlyle 2-3360
 Greene, Gordon W. 2-3231, 2-3592
 Griffiths, T.M. 2-3202
 Griffiths, Wallace R. 2-3234, 2-3534, 2-3537
 Grigorev, V.N. 2-3271
 Grimaldi, Frank S. 2-3431
 Guerrero, E.T. 2-3380
 Guillou, Robert B. 2-3418
 Gulbrandsen, Robert A. 2-3504, 2-3572
- Hack, John T. 2-3219
 Hackman, Robert J. 2-3600
 Hadley, Jarvis B. 2-3169
 Hail, William J., Jr. 2-3301, 2-3309
 Hall, William B. 2-3175, 2-3176
 Hamilton, John C. 2-3454
 Hamilton, Warren B. 2-3164, 2-3196, 2-3264, 2-3312, 2-3314, 2-3495
 Hansen, Wallace R. 2-3307
 Hanshaw, P.M. 2-3452
 Hanson, Alvin M. 2-3177
 Harris, Leonard D. 2-3274
 Hartshorn, Joseph H. 2-3147
 Hawkins, D.B. 2-3533
 Hawley, C.C. 2-3234, 2-3559
 Hayes, Philip T. 2-3196
 Healey, D.L. 2-3428
 Helnes, John T. 2-3575
 Helz, Armin W. 2-3430
 Henbest, Lloyd G. 2-3320, 2-3330
 Henderson, E.P. 2-3207
 Henderson, Roland G. 2-3349
 Herrick, Eugene H. 2-3525
 Hertlein, Leo G. 2-3337
 Hess, H.H. 2-3249
 Heyl, Allen Van, Jr. 2-3547
 Hildebrand, Fred A. 2-3557
 Hinrichs, E. Neal 2-3515
 Hintze, Lehi F. 2-3178
 Hobbie, John E. 2-3199
 Hofmann, R.B. 2-3389
 Hogberg, Rudolph K. 2-3185
 Honkala, Fred S. 2-3165
 Hood, James W. 2-3524
 Hopkins, David M. 2-3311
 Hosterman, John W. 2-3562
 Houser, Frederick N. 2-3148, 2-3258
 Hoyte, Alfred F. 2-3449
 Huffman, Claude, Jr. 2-3440
 Hughes, Owen L. 2-3141
 Hull, Paul 2-3417
 Hummel, C.L. 2-3539, 2-3545
 Hunt, Charles B. 2-3197, 2-3213, 2-3462, 2-3509, 2-3519
 Hussey, Keith M. 2-3315
- Imlay, Ralph W. 2-3327, 2-3328
 Ingerson, Earl 2-3544
 Irwin, William P. 2-3269
- Jackson, Everett D. 2-3438
 Jackson, W.H. 2-3216, 2-3347
 Joesting, Henry R. 2-3241
 Johnson, Robert W., Jr. 2-3358
 Jones, David L. 2-3295
 Jones, Robert E. 2-3381, 2-3382
- Kachadoorian, Reuben 2-3143, 2-3144
 Kane, Martin F. 2-3339, 2-3429
- Kansas Geological Society 2-3131
 Kaplun, L.I. 2-327
 Karlstrom, Thor N.V. 2-3154, 2-320
 Kazinsky, V.A. 2-3336, 2-333
 Keefer, William R. 2-32
 Keller, B.M. 2-328
 Keller, George V. 2-3385, 2-34
 Kent, D.M. 2-327
 Kents, Paul 2-328
 Kerr, Paul F. 2-351
 Keylis-Borok, V.I. 2-34
 Khayritdinov, R.K. 2-341
 Khovanova, R.I. 2-335
 King, Elizabeth R. 2-335
 Kinney, Douglas M. 2-330
 Kinser, Charles A. 2-34
 Klink, Karin E. 2-351
 Knechtel, Maxwell M. 2-356
 Kogan, V.D. 2-356
 Kondorskaya, N.V. 2-335
 Kopeliovich, A.V. 2-351
 Koschmann, A.H. 2-315
 Kovar, Anton J. 2-358
 Kravchenko, S.M. 2-349
 Kremp, G.O.W. 2-358
 Kudryakova, V.A. 2-347
 Kupsch, W.O. 2-359
- Lachenbruch, Arthur H. 2-3210, 2-3212, 2-359
 Ladd, Harry S. 2-3325, 2-351
 Landis, E.R. 2-324
 Lane, D.M. 2-327
 Lebedev, A.P. 2-348
 Lebedinsky, V.I. 2-348
 Lee, Hulbert A. 2-320
 Leggat, Edward R. 2-352
 Leighty, Robert D. 2-358
 Leonov, N.N. 2-339
 Leopold, Estella B. 2-330
 Lewis, G. Edward 2-3309, 2-331
 Lewis, Peirce F. 2-322
 Lindberg, Marie Louise 2-3470, 2-347
 Liu, You-hsin 2-355
 Livingston, Alfred, Jr. 2-359
 Lossovsky, E.K. 2-339
 Luedke, Robert G. 2-324
 Lustig, E.N. 2-325
 Lyons, L.A. 2-317
 Lyubimova, E.A. 2-342
- Mabey, Don R. 2-3343, 2-334
 McAleer, Joseph F. 2-316
 McCabe, Hugh R. 2-328
 McCulloh, Thane H. 2-334
 McKee, Edwin D. 2-3283, 2-350
 McKeown, Francis A. 2-3405, 2-358
 MacKevett, E.M., Jr. 2-354
 Mackin, J. Hoover 2-354
 McLean, Douglas D. 2-327
 MacNeil, F. Stearns 2-331
 McThenia, Andrew Wolfe, Jr. 2-317
 Makarova, Z.V. 2-336
 Malde, Harold E. 2-321
 Malyshev, V.I. 2-353
 Mamay, Sergius H. 2-3333, 2-333
 Mann, John A. 2-316
 Markhinin, E.K. 2-337
 Marranzino, A.P. 2-354
 Martinez, Prudencio 2-341
 Maslov, V.P. 2-333
 Masursky, Harold 2-351
 Mattson, Peter H. 2-3240, 2-351
 Matveev, B.K. 2-337
 Matveevskaya, A.L. 2-319
 May, Irving 2-343
 Meyrowitz, Robert 2-347
 Minard, James P. 2-3259, 2-347
 Minato, Masao 2-349
 Mitich, G.B. 2-350
 Mo, Ke-Min 2-348

GEOSCIENCE ABSTRACTS

Abstract		Abstract	
Broe, Watson H.	2-3220	Robinson, Thomas W.	2-3519
Core, George W.	2-3224	Roller, J.C.	2-3404, 2-3428
Core, James G.	2-3291	Rosholt, John N., Jr.	2-3550
Critz, Carl A.	2-3180	Ross, Clyde P.	2-3281
Dillieux, D.R.	2-3480	Rukavishnikova, T.B.	2-3276
Dinin, A.S.	2-3402	Russell, R.D.	2-3464
Evers, Alfred T.	2-3454		
Evers, Donald A.	2-3286	Sainsbury, Cleo L.	2-3546
		Sainikov, B.A.	2-3308
Ikagawa, H.M.	2-3462, 2-3534	Sando, William J.	2-3285
Iivkin, D.V.	2-3266	Savarensky, E.F.	2-3397, 2-3401
Iumova, S.N.	2-3336	Schaeffer, Adrian E.	2-3221
Iodostup, G.A.	2-3421	Schlanger, Seymour O.	2-3517
Ippochinov, Yu. P.	2-3403	Schlocker, Julius	2-3501
Iuman, Robert B.	2-3270	Schmidt, Robert G.	2-3418
New York State Geological Association	2-3186	Schneerson, B.L.	2-3365
ewcomb, Reuben C.	2-3528	Schnepe, Marian M.	2-3435
hols, Donald R.	2-3505	Schultz, Leonard G.	2-3457
kiforova, N.N.	2-3373	Schumm, Stanley A.	2-3215
orton, James J.	2-3493	Segerstrom, Kenneth	2-3214
		Semikhatov, M.A.	2-3271
ukhov, V.A.	2-3387, 2-3388	Seftle, Frank E.	2-3463, 2-3471
U.	2-3537	Shacklette, Hansford T.	2-3538, 2-3540
io, Division of Water	2-3526	Shafiro, Ya. Sh.	2-3262
iver, Howard W.	2-3346	Shapiro, Leonard	2-3448
iver, Thomas A.	2-3292	Sharp, W.N.	2-3234, 2-3559
iver, William A., Jr.	2-3322	Sheffey, Nola B.	2-3458, 2-3459, 2-3460
shansky, Ya. I.	2-3494	Shelden, Arthur W.	2-3174
sterwald, Frank W.	2-3587	Sherwood, Alexander M.	2-3453
Sullivan, John Blandford	2-3315	Shilov, V.N.	2-3482
terbridge, William F.	2-3409	Shirokova, E.I.	2-3392
verstreet, William C.	2-3150, 2-3189, 2-3455	Shkabarnya, N.G.	2-3375
Wens, James P.	2-3259, 2-3476, 2-3558	Shoemaker, Eugene M.	2-3584
		Silberling, Norman J.	2-3502
		Sims, Paul K.	2-3566
akiser, Louis C.	2-3232	Sinclair, William C.	2-3523
allister, Alfred E.	2-3408	Sloane, Bruce C.	2-3173
almer, Allison R.	2-3272	Smedes, Harry W.	2-3158
asechnik, I.P.	2-3386	Smirnov, V.I.	2-3530
aul, H.P.	2-3172	Smith, George I.	2-3229
avilides, Louis	2-3496	Smith, Patsy Beckstead	2-3331
ase, Maurice H., Jr.	2-3239, 2-3490	Smith, William Lee	2-3453
echersky, D.M.	2-3371	Socolow, Arthur A.	2-3361, 2-3363, 2-3364
ack, Dallas L.	2-3479	Solovov, A.V.	2-3263
elletier, B.R.	2-3288	Somerton, W.H.	2-3424
eselnick, Louis	2-3409	South Texas Geological Society	2-3191
eterson, Donald W.	2-3145	Staat, Mortimer H.	2-3237
strushevsky, B.A.	2-3394	Stackler, W.F.	2-3342
erce, Arthur P.	2-3578	Stadnichenko, Taisia M.	2-3458, 2-3459, 2-3460
erce, William G.	2-3238	Stager, Harold K.	2-3560
oshko, V.V.	2-3477	Stalker, Archibald M.	2-3204
odyapolsky, G.S.	2-3399	Stern, Thomas W.	2-3316
ommer, Alfred M.	2-3441, 2-3434, 2-3258	Steven, Thomas A.	2-3567
oole, Forrest G.	2-3142	Stevens, Rollin E.	2-3433
oole, W.H.	2-3142	Stewart, F.M.	2-3380
opov, E.I.	2-3341	Stewart, John H.	2-3548
opov, Yu. N.	2-3326	Stewart, Samuel W.	2-3389, 2-3404
ospelova, G.A.	2-3372	Strickland, John W.	2-3179
ostolenko, G.A.	2-3393	Sukhodolsky, V.V.	2-3340
oulin, Ambrose O.	2-3588	Sutton, Robert G.	2-3279
owers, Howard A.	2-3483, 2-3577	Swanson, Roger W.	2-3564
ressman, A.E.	2-3577		
		Tabulevich, V.N.	2-3407
am, Louis O.	2-3597	Tanner, Allan B.	2-3419
		Tatlock, Donald B.	2-3502
ndbruch, Dorothy H.	2-3589	Taylor, Richard Spence	2-3205
nder, Lewis F.	2-3443	Terasmae, Jaan	2-3313
ndforth, Norman W.	2-3313	Thayer, T.P.	2-3289
tté, James C.	2-3567	Thellier, E.	2-3348
vich, M.G.	2-3195	Thellier, O.	2-3348
y, Louis L.	2-3218	Thomas, Leo A.	2-3156
ad, Charles B.	2-3333	Thompson, Ted	2-3521
ed, John C., Jr.	2-3236	Thorpe, Arthur	2-3471
ch, Ernest I.	2-3296	Tikhonov, A.N.	2-3376, 2-3377
chmond, Gerald M.	2-3209, 2-3314	Timofeev, A.N.	2-3420
chter, Donald H.	2-3347	Tompson, Willard D.	2-3168
ach, Carl H.	2-3531	Tourtlot, Harry A.	2-3457
berts, Ralph J.	2-3573	Trace, Robert D.	2-3571
binson, G.D.	2-3303	Truesdell, Alfred H.	2-3551

GEOSCIENCE ABSTRACTS

Abstract

Abstract

Tschanz, Charles M.	2-3305
Tuchkov, I.I.	2-3290
Tutten, William D.	2-3183
Tweto, Odgen	2-3233, 2-3566
Udintsev, G.B.	2-3252, 2-3403
U.S. Bureau of Reclamation, Design and Construction Division	2-3518
U.S. Geological Survey	2-3146, 2-3596
U.S. Geological Survey, Military Geology Branch	2-3595
Utrobin, V.N.	2-3335
Van Alstine, Ralph E.	2-3310
Vanlier, Kenneth E.	2-3522
Vasilev, Yu. M.	2-3211
Vedder, John G.	2-3324
Vinogradov, S.D.	2-3411
Vinokurov, V.M.	2-3475
Vladimirov, N.P.	2-3373
Voskuil, Walter H.	2-3529
Walker, E.C.	2-3463
Walker, George W.	2-3306
Wallace, Robert E.	2-3502, 2-3569
Ward, Frederick N.	2-3462
Warr, Jesse J.	2-3432, 2-3444, 2-3445, 2-3446
Washburn, A.L.	2-3213
Weaver, Mary A.	2-3589
Weeks, Alice D.	2-3551, 2-3553
Weis, Paul L.	2-3570
Wellings, F.E.	2-3581

West Texas Geological Society	2-31
Wheeler, Walter H.	2-33
White, Donald E.	2-34
White, Walter S.	2-32
Whitmore, Frank C., Jr.	2-33
Wilcox, Ray E.	2-35
Willden, Ronald	2-3304, 2-35
Williams, John R.	2-32
Williams, Milton	2-34
Wilmarth, Verl R.	2-3423, 2-3585, 2-35
Witkind, Irving J.	2-31
Wood, Gordon H., Jr.	2-32
Woodard, F.W.	2-31
Wright, James C.	2-32
Wright, Thomas L.	2-34
Wyoming Geological Association	2-31
Yagi, Kenzō	2-34
Yanovskaya, T.B.	2-34
Young, E.J.	2-35
Zablocki, C.J.	2-33
Zaklinskaya, E.D.	2-33
Zapp, Alfred D.	2-32
Zappa, Theodore A.	2-35
Zavaritsky, V.A.	2-34
Zen, E-an	2-35
Zharkov, V.N.	2-34
Zietz, Isidore	2-3245, 2-3351, 2-33
	2-3354, 2-3355, 2-3360, 2-34
Zubovic, Peter	2-3458, 2-3459, 2-34

